PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. I.

1861, NOVEMBER 20, TO 1863, JUNE 17.

LONDON:
TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.
AUGUST 1863.

PREFACE.

The following passage, from a communication from the pen of John Drew, Esq., F.R.A.S., and one of the original Members of this Society, refers to the institution of the Society. It is dated May 18, 1850, and appeared in 'The Civil Engineer and Architect's Journal' for July 1850:—

"The noble mansion of Hartwell, situated in the fertile vale of Aylesbury, and at the foot of the Chiltern Hills . . . . In the spacious and elegant library Louis XVIII. attached his signature to the document which restored him to the throne of his ancestors. With objects far other than political, a few lovers of science had assembled in this room, at the invitation of the present proprietor, Dr. Lee, on the 4th of April, 1850, for the purpose of taking into consideration the present state of meteorology, and of adopting such measures as might conduce to its advancement. The result of their deliberations was the formation of a Society to be called the 'British Meteorological Society,' of which Dr. Lee was

appointed Treasurer, and James Glaisher, Esq., F.R.S., F.R.A.S. (of the Royal Observatory, Greenwich), Secretary. The second meeting of the Council was held on the 7th of May. Within a month, the Society has numbered ninety-five Members, has elected as President S. C. Whitbread, Esq., F.R.A.S.; as Vice-Presidents, Lord Robert Grosvenor, M.P., Hastings Russell, Esq., M.P., General Sir Thomas Brisbane, K.C.B., F.R.S., and Luke Howard, Esq., F.R.S."

The successive Presidents have been S. C. Whitbread, Esq., F.R.A.S.; George Leach, Esq., F.Z.S.; Dr. Lee, F.R.S.; Robert Stephenson, Esq., F.R.S.; Thomas Sopwith, Esq., M.A., F.R.S.; N. Beardmore, Esq., C.E., F.R.A.S.; and the President elect, Robert Dundas Thomson, Esq., M.D., F.R.S. L. & E., &c.

The First Volume of the 'Proceedings of the British Meteorological Society' is now in the hands of Members, and will itself explain better than words can do the plan which the Council have endeavoured to carry out. Their wish has been that each successive Number of the 'Proceedings' should appear as soon as possible after the day on which the Meeting was held to which the Number refers. The publication is not only intended to place before Members the election-lists and the papers read, but to call their attention to books published, instruments introduced, papers read elsewhere, and to other sundry items of meteorological news.

For the sessions that were held from the institution of the Society to the time when the 'Proceedings' were first issued, Annual Reports were made, which more or less referred to the status and the finance of the Society, and which gave, in whole or in part, the papers read at the Ordinary Meetings. Of some of these Annual Reports the stock is exhausted, and complete sets are not now to be obtained. The following is a very brief analysis of the extent and contents of these Reports:—

The Papers printed, in whole or in part, in these Annual Reports, are :—

SESSION 1852–53.

Register kept on Board H.M. Ship 'Sophia' in Arctic Regions. P. C. SUTHERLAND, Esq.
Meteorology of England in 1848. J. GLAISHER, Esq.
Observations of Thermometer for 25 years. C. BULARD, Esq.
Earthquake in England. J. GLAISHER, Esq.; also Dr. MOFFATT.
Register kept at Texas, &c. R. GUILLMETTE, Esq.
Meteorology for 1852. J. GLAISHER, Esq.
Evaporation. Capt. CLERK, R.A.
Medical and Agricultural Meteorology. Dr. MOFFATT.
Meteorological Observations, Carthagena, &c. L. GISBORNE, Esq., and H. C. FORDE, Esq.

SESSION 1853–54.

Meteorology of 1853–54. JAMES GLAISHER, Esq.
Meteorological Report for 1852. Dr. SMALLWOOD.
Medico-Meteorology and Ozone. Dr. MOFFATT.
Law in the Direction of the Wind. C. BULARD, Esq.
Rain-fall 1852–53. JAMES GLAISHER, Esq.
Meteorological Observations at Montreal. Dr. SMALLWOOD.

SESSION 1854–55.

The Weather and the Growth of Hops. F. W. DOGGETT, Esq.
Evaporation. Dr. G. BUIST.
Severe Weather 1855; Snow-crystals (with Thirty-six Plates, containing 151 figures of Snow-crystals). JAMES GLAISHER, Esq.

SESSION 1855–56.

Mercurial Minimum Thermometer. NEGRETTI and ZAMBRA.
Weather in connexion with the Wheat Crop. F. W. DOGGETT, Esq.
Meteorology near Montreal. Dr. SMALLWOOD.
Medical Meteorology. Dr. MOFFATT.
Ozonometers of Schönbein and Moffatt. Dr. BARKER.

SESSION 1856–57.

Lightning-Pictures. M. POËY; also J. B. SHAW, Esq.
Self-registering Sun-dial. J. F. CAMPBELL, Esq.
Barometrical and Thermometrical Notes at Sinope. J. N. RADCLIFFE, Esq.
Ozone at Newport and Staplers. J. BLOXAM, Esq.
Mean Temperature of every Day in the Year. JAMES GLAISHER, Esq.

SESSION 1857–58.

Fall of Rain, October 22, 1857. JAMES GLAISHER, Esq.
Meteoric Iron of Atacama. W. BOLLAERT, Esq.
Climate and Mortality of London in 1857. Dr. TRIPE.
Periodical Phenomena, 1855, 1856, and 1857. JAMES GLAISHER, Esq.
Meteorology of 1855, 1856, and 1857. JAMES GLAISHER, Esq.
Meteorology of Solar Eclipse, March 15, 1858. JAMES GLAISHER, Esq.

SESSIONS 1858–59 and 1859–60.

Practical Importance of Meteorology. T. SOPWITH, Esq.
Meteorology of the Arctic Seas. Dr. WALKER.
Mean Pressure of the Atmosphere for every Day of the Year. JAMES GLAISHER, Esq.
Atmospheric Conditions and Ozone. H. S. EATON, Esq.
Nature and Origin of Aurora. Rev. G. FISHER.
Meteorology and Mortality of 1858. Dr. TRIPE.
Meteorology of Scarlatina. G. V. VERNON, Esq.
Cold-term in Canada, January 1859. Dr. SMALLWOOD.
Mode of observing Ozone. Dr. SMALLWOOD.
Medical Meteorology and Ozone. Dr. MOFFATT.

SESSION 1860–61.

Medical Meteorology and Ozone. Dr. MOFFATT.
Extraordinary Cold Weather, 1860–61. JAMES GLAISHER, Esq.

Auroral Phenomena. Lieut. CHIMMO.
The Weather, October 1859 to December 1860. JAMES GLAISHER, Esq.
Barometer Indicators. T. SOPWITH, Esq.
Auroral Phenomena. J. E. WOOD, Esq.
Observations on Aurora Borealis. Rev. G. FISHER.
Extraordinary Cold in America, February 1861. JAMES GLAISHER, Esq.
Loss of Colour in Ozone Papers. Dr. MOFFATT.

From this period the papers that have been communicated to the Society will be found in their place in the present volume.

The numerical strength of the Society, represented by the contributions of the Ordinary Members, has fluctuated in a somewhat irregular manner. The total amount paid in for entrance-fees and annual subscriptions, since the foundation of the Society in 1850 to the end of 1862, has been £1594 14*s*. 9*d*. Taking account of probable entrance-fees to June 1861, when they were abolished, the approximate mean annual number of subscriptions has been 112. The contributions for the first year, including admission-fees, were £129. The total contributions for the two years, 1861 and 1862, were £213; this is exclusive of outstanding subscriptions.

The number of Ordinary Members on the Register of the Society at the dates when the several lists of Members have been printed are—

1850, December 31	145	Ordinary Members.
1851, December 31	165	" "
1856, March	173	" "
1862, August	203	" "
Present number	240	" "

The total number of Members who have compounded is 31; the amount received for compositions is £364 12*s*. Of this sum £215 14*s*. 10*d*. has been invested in the purchase of stock in the New Three per Cents.; the last purchase was made with

£46 12*s*. 6*d*. in June 1862. The total amount of stock in the New Three per Cents. belonging to the Society, and held in the names of Dr. Lee, Mr. Whitbread, Mr. Perigal, and Mr. Glaisher, is £450, which cost £415 14*s*. 10*d*. Of this sum £200 is a legacy left to the Society by one of its Members, H. Lawson, Esq., F.R.S., F.R.A.S., who was elected into the Society May 7th, 1850, and who died at Bath on August 22nd, 1855, in the 82nd year of his age.

The details, from which this very concise analysis of the past progress of the Society has been taken, are to be found in the eleven Annual Reports, and are placed here, in the Preface of this First Volume of the 'Proceedings,' because the original documents are in part out of print, and, except the one copy in the Society's Library, are almost inaccessible to new Members.

Six Numbers of the 'Proceedings' will in future appear during each Session, to correspond with the number of Meetings, now increased from four to six.

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Vol. I.] [No. 1.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

1861, NOVEMBER 20.

CONTENTS.

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1862, *February* 10.

PRINTED BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

NOTICE TO MEMBERS.

The Council desire to issue 'The Proceedings of the British Meteorological Society' four times during the year; and to issue each Number as soon as possible after the Ordinary Meeting to which it refers.

One copy of each Number will be forwarded *free* to each Member of the Society.

The 'Proceedings' will be published by Messrs. Taylor and Francis; and each Number will show the price at which it will be sold to the public; and which will also be made known, together with the day of publication, by public advertisement.

The "Publication Committee" request the co-operation of Members, in communicating information, and in promoting the establishment of the 'Proceedings' on a permanent basis.

No. 2 of the 'Proceedings,' being the Report of the Meeting in January 1862, &c., is in the press, and will shortly be in the hands of Members.

*** The Report for the year ending 1861, June 12, is in hand. Each Member will receive his copy as usual, when it is ready.

Members are informed that, at the Annual General Meeting held 1861, June 12, certain alterations were made in the "Institutes" of the Society.

1. The Admission Fee of £1 is abolished; the Annual Contribution remaining £1 as heretofore.
2. The Composition Fee is made £10 instead of £12.
3. Council Meetings are reckoned as Ordinary Meetings for promoting the election of Members, except that the Election itself must take place at an Ordinary Meeting.

[*Advertisements continued on the third page.*

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

Vol. I.] 1861, NOVEMBER 20. [No. 1.

N. BEARDMORE, Esq., C.E., F.R.A.S., President, in the Chair.

Arthur John Joyce, Esq., 31 Upper Gower Street, Bedford Square;
George Farren, Esq., 18 Whitehead Grove;
Francis Galton, Esq., M.A., F.R.S., Hon. Secretary to the Royal Geographical Society of London;
were balloted for and duly elected Members of the Society.

The President delivered the following Inaugural Address:—

Gentlemen,

In commencing business at the First Meeting of the Session 1861–62, I will trespass for a few minutes on your time, in order that we may revert to some points of Meteorology, in which as a Society, and more especially as an Association, composed in a great measure of practical observers, we are all deeply interested.

And first, to revert to the unrequited labours of our observing Members. We must not forget that our Society has now been in existence for a period of eleven years, during the whole of which time observations have been kept at many stations throughout the country without a break in their continuity. They afford data for determining the peculiar features of the climate of England with a considerable degree of accuracy. In some in-

stances local climate has been investigated by individual Members, and the particulars have been communicated at the Ordinary Meetings of our Society.

In a science which involves so many remote and as yet unknown causes, one cannot avoid feeling that we are but picking up pebbles on the shore, while the great depths before us are still unfathomed. We must observe, record, and collate, if we would arrive at first causes; and it has been the great object of the well-known promoters of this Society to make it above all things one for collection of strict and scientific data by accurate instrumental means.

In addition to the now large mass of observations which have been preserved in a continuous form, I will briefly recount a few of the labours of the more prominent Members of this Society.

We have the admirable photo-recording system of Mr. Brooke, our esteemed Vice-President, perpetually registering the atmospheric and magnetic variations at Greenwich and at Kew, but perhaps more extensively adapted for the thermometer and barometer by our lamented Member, the late Manuel Johnson at the Ratcliffe Observatory. The Brooke-method adopted there might with advantage be much extended in private observatories, and at very little expense or trouble.

Our annual records have from time to time contained Mr. Glaisher's grouping and analysis of Greenwich Meteorological Observations; and the recent annual volume has a further paper by that gentleman on the barometrical observations at Greenwich from 1841 to 1858, which contains most invaluable matter for reference. Mr. Glaisher has also continually assisted the public, as Secretary of your Society, by directing his attention to the practical application of meteorological science to questions of water-supply, drainage, and other important questions raised in a science, the phenomena of which have so wide a range, and where exceptions rather than rules are the important matter.

The exertions of your Vice-Presidents, Dr. R. D. Thomson and Dr. Tripe, have long been directed to the health of the metropolis, and its connexion with its meteorology; and their exertions, united with those of a band of zealous workers in the same field, reflect honour on themselves, and give fair grounds for congratulation to the Society of which they have been strenuous supporters.

At a period when electricity and magnetism take so large a share in the practical business of life, I shall not be considered to travel out of the science in referring to the great desideratum

there is for stricter investigation into the connexion of these occult fluids with the more ordinary observed meteorological changes.

There is every reason to believe that the perturbations observable in the photosphere of the sun react on our atmosphere: a secular period of eleven years has been discovered by Dr. Wolf in these disturbances as indicated by the presence of spots on the sun's disc. When these are at a maximum, auroræ boreales and magnetic storms occur most frequently. The years 1859 and 1860 were alike remarkable for great changes in the luminous envelope of the sun, magnetic storms, and other non-periodic meteorological disturbances. The Rev. F. Howlett, in a recent communication to the Astronomical Society, remarks, "that the wonderful commotions exhibited on the solar surface during the years 1859 and 1860 have not been equalled at any period during 1861. These commotions would appear to be now calming down —consistently so far with the much-discussed eleven-year cycle of maximum and minimum of spots." If even one daily photograph of the sun were taken at Kew by Mr. De la Rue's photoheliometer, the decimal proportion of spots and disturbed surface might be recorded in a simple manner by micrometric squares placed over the sun's image: a system of comparison of these results with other elements would not be long in developing new and perhaps unexpected phenomena. In connexion with this field of inquiry, our excellent Secretary, Mr. Walker, has made arrangements for recording observations on earth-currents, and is at present engaged in discussing the subject with a great degree of success. It would be desirable if this subject, with that of electric tension, could be taken up by our observing Members as a matter of systematic record*.

The method of recording and signalling by telegraph simultaneous observations of the barometer, wind, and temperature which prevail over wide areas, has of late years assumed a very prominent position. In July 1856, M. Le Verrier of the Imperial Observatory, Paris, introduced the system of having the state of the weather at different points in the empire telegraphed to the Observatory, where the observations were reduced and issued in the form of a daily bulletin. His labours met with complete success; and before long telegraphic returns were received from nearly every country in Europe, which were immediately published for the benefit of the public, both separately and in the leading French journals. It was soon found that the principal meteoro-

* This subject is noticed in a future page of this Number.

logical disturbances were propagated in a direction from west to east: it became a matter of consequence that Great Britain, an outpost in the western ocean, should be included in the scheme, and this was finally accomplished at the commencement of the year 1860. Your Vice-President, Admiral FitzRoy, under the direction of Government, has established meteorological stations at the principal outlying seaports of the United Kingdom: the observations at 8 A.M., taken at these posts and at several foreign stations, are telegraphed to the Board of Trade, where they are reduced and the results prepared in time for publication in the evening papers of the same day. The probable approach of storms is signalled to the principal fishing stations and seaports which Admiral FitzRoy may judge likely to be affected by their transit. Our late President, Mr. Sopwith, and our zealous and experienced Secretary, Mr. Glaisher, co-operating with the Duke of Northumberland, have been very active in establishing similar means of warning for the sailors and fishermen on the Northumberland coast, by placing barometers at many of the villages, through the medium of your Society. In a letter addressed very recently to the Lifeboat Association, Captain Washington, Hydrographer of the Admiralty, says, "The fishermen, I am told, take to them most kindly; and, notwithstanding the favourable appearance of the morning, if the barometer has fallen much, they accept the warning and remain on shore." Members of the Society will gather from the Address delivered by our late President, Mr. Sopwith, on leaving the Chair, that in all human probability much property and many lives have been saved by attending to these faithful monitors. The Meteorological Society of Scotland have the advantage of small assistance from Government, on condition of upholding similar stations along that stormy coast.

Now that our Government has taken the initiative in making a practical use of meteorology, it is to be hoped that Admiral FitzRoy, who is conducting with so much zeal and energy the Department, of which he is the chief, will be allowed sufficient funds for the perfect collation and scientific record, and subsequent publication of the Board of Trade observations in a form more adapted for research than the daily publication can be expected to reach These documents should be issued at least monthly; and there would be great value attached to them if Le Verrier's bulletins were included with them, after reducing the French into English measures, and condensing such of the observations as from their propinquity may be merely repetitions

of each other. Simplicity and perfect accuracy, with careful distribution of stations, in the pursuit of what may be termed *synchronous meteorology*, is of far more importance than voluminous multifarious returns.

Our new Member, Mr. Francis Galton, the indefatigable Foreign Secretary of the Royal Geographical Society, has undertaken the laborious task of himself collecting and reducing at his own expense, for the month of December 1861, all the available meteorological observations taken between the latitudes 42° 25′ and 61° north, and from the west of Ireland as far east as Russia. He proposes to exhibit the principal changes that may occur graphically in a series of maps, which he has most handsomely promised to present gratuitously to the contributors. He has obtained the co-operation and cordial assistance of Quetelet, Lamont, Dove, Kreil, Oersted, and other well-known continental meteorologists, names which represent extensive Societies. I trust he will be able to get through the collation of this great work and labour of love, and give your Society what will not fail to afford a most valuable contribution to the science of meteorology.

It is most important to bear in mind that no amount of knowledge, attained on the small portion of the globe forming this island, can for a moment be considered to embrace meteorology as a science. It should be the object of your Society to extend the system of observations over the wide area of our British Colonies. In some of these, proper observatories have been long established; but there are others where the observations are desultory, or, where made correctly, are useless from want of publication. In this respect the Continental governments present an example worthy of admiration; in proof of this I propose to lay before you a short statement of the stations whose records are under regular publication.

In Belgium, Professor Quetelet's labours are well known for the acumen with which he pushes his researches.

In the Netherlands, MM. Kreke and Buys Ballot publish *in extenso* observations made at eleven stations, besides reducing others made over the whole of Europe and in Batavia: the results are published annually in a quarto volume of 400 pages.

In Sweden there are twenty-one stations: observations are taken at each of them three times a day, and, after reduction by Dr. Lindhagen, are annually published in full.

In Norway, Professor Hansteen has been unable to establish more than three or four stations.

In DENMARK, meteorological science is represented by Oersted.

In NORTH GERMANY, Dove has established, and for some years published monthly the records of, 90 or 100 stations.

In the AUSTRIAN EMPIRE, the illustrious Kreil has the direction of no less than 140 stations: the Austrian Government annually publishes the results procured from these in one of the finest meteorological works extant.

At ST. PETERSBURG, Kupffer, of world-wide fame, superintends about thirty stations scattered over the broad expanse of Russia and Siberia. The records of many of these are rendered peculiarly valuable, inasmuch as a complete register of the hourly observations is printed.

At ATHENS, Julius Schmidt has recently sent forth a fine set of meteorological tables from the observatory there.

In ITALY, I am not aware whether there is any special body devoted to the prosecution of meteorological research: there are, however, some literary societies in the North which encourage a pursuit of the science; and Secchi at Rome, Luigi Palmieri and Patrelli at Naples are names well known in the meteorological world.

In SPAIN, you are aware that Don Manuel Rico y Sinobas, after communication with your Society, established some twelve or fourteen stations; but the records appear not to have been systematically published, with the exception of those at Madrid.

In FRANCE, I have already spoken of Le Verrier's labours; there is a Meteorological Society in that country, but since the establishment of the important government 'Bulletin,' it has ceased to issue any publication. Several of the literary societies of the more important towns in France make meteorology a part of their regular pursuits. Algeria may be included in this catalogue. One of the most interesting labours has been that of the Hydraulic Commission of Lyons, by whom twelve stations were kept in the basin of the Saone, in order to ascertain the rain falling on the flanks of the Jura; the amount of water discharged by the river was gauged daily for ten years, and the comparative results have been published.

In SWITZERLAND, Plantamour and others have prosecuted meteorological researches during the present century, perhaps more than any other individuals, in the 'Proceedings' of the Natural History Society of Geneva.

Very recently the Helvetic Society has determined on establishing eighty-four meteorological stations on the High Alps, in

connexion with regular observatories. It is hoped to arrive more fully at a knowledge of the laws which regulate the movements of the atmosphere at great elevations; and especially the effect which the great barrier of the Alps produces on the climate of Europe. It is a well-known fact that opposite meteorological conditions prevail at the same time on the north and south sides of the Alps. Kaemtz, the illustrious meteorologist at Dorpat, has given his approval to the undertaking. This may be an excellent opportunity for a further investigation of the relative fall of rain at different levels on the slopes of the Alps, as an extension of Schouw's inquiries: much light may yet be thrown upon the subject.

In Portugal, the sovereign, Don Luiz, takes much interest in marine meteorology: he has an observatory at Lisbon. Placed as it is, an outpost in the Atlantic, the coast of Portugal offers a suitable field for the extension of meteorological stations.

On the continent of North America we find no fewer than 500 stations, principally under the direction of the Smithsonian Institution. Meteorological registers are kept at the outlying forts and military posts in America—many of them on the confines of the Great Desert of New Mexico, and the far regions of the West. Some of the meteorological conditions, as regards temperature and the distribution of rain, are very peculiar, and are interesting from being taken in positions which would otherwise be inaccessible.

Canada has its official observatories. And we have the advantage of a valuable correspondent in Dr. Smallwood, who gives us the latest information.

Scotland:—Drawing nearer home, the northern part of this island is represented by the Scottish Meteorological Society, which now reports from about sixty stations. The observations are reduced by Professor Piazzi Smyth at the Observatory, Calton Hill, and subsequently handed over to the Council of the Society. At the coast stations careful records are kept of the temperature of the sea; and the temperature of the ground, at different depths below the surface, is noted at a large number of places. There are many of our own stations where these subjects might be taken up with advantage.

Ireland, although it has the excellent observatories of Armagh and Markree, besides a few other stations of the Royal Engineers, and private institutions, does not contain a Meteorological Society. It would not be difficult to obtain the cooperation of the Board of

Works at Dublin, who would have it in their power to obtain returns by means of the county surveyors and other officers. Occasional records have been kept at the new Colleges: the learned professors might keep them systematically, if they felt that their returns were valued.

With regard to the meteorology of the past year, we have just passed through a spring, summer, and autumn whose warmth and genial character has been universal, from the western side of this island to and over the whole European and North American continents; although, singularly, the west of Ireland has experienced its bane, that of a wet and stormy summer. While this drought has prevailed, the great mountain districts and high places of Abyssinia and Central Africa have been visited with deluging rains, as evinced by the extreme height of the Nile flood of this October. Simultaneously an unusual deluge has accompanied the bursting of the monsoon over the plains of India. Comparing the general characters of the meteorology of the present year with that of the past (1860) in our northern hemisphere, we have opposite conditions in every respect: North America and Europe had both cold and wet summers, while the plains of India lacked their annual and periodic supply of rains, so as to have produced a considerable extent of famine.

These broad facts, of what may be termed grouping of certain meteorological extremes, are not new or singular; they deserve the careful scrutiny of those of our Members who have time and courage to investigate such a vast field of research.

In concluding these remarks, I have the authority of your Council for stating that it has been felt for some time past to be desirable that papers read at the Ordinary Meetings should be placed in the hands of Members and the public promptly, so as to be more available. It has therefore been resolved to commence with the Session 1861–62, a Journal of a character similar to those of other scientific bodies. Your Secretaries are kindly ready to give every assistance in forwarding this desirable measure; and I have earnestly to crave the co-operation of all our Members, in order that the work, once commenced, may be kept up to the advanced standard of the science maintained by your Society, and required by the useful competition of kindred associations.

I. *On the Fall of Rain in Devonshire.*

By Henry Storks Eaton, Esq., M.A., Librarian.

[Abstract.]

There are, perhaps, few influences so intimately connected with the welfare of an agricultural country as a moderate and constant supply of rain. In combination with the temperature of the air, it determines the profitable cultivation or otherwise of different soils. Thus in Ireland and the hilly districts of Great Britain, under a cloudy and rainy sky, we find a large portion of the land devoted to pasturage and the culture of root crops, and much of it is covered by bog; in the drier midland and eastern counties of England wheat is raised with advantage on the stiff clay lands.

In another point of view we are told that rainy districts and seasons have their peculiar diseases, which are replaced by others of a different type when opposite conditions obtain, as may be well seen in the 'Reports' of the Registrar-General.

Again, in supplying towns with water, the fall of rain in the locality whence the water is obtained is a subject which requires a careful examination to arrive at a knowledge of the average amount and the probable fluctuations to which it is liable.

In investigating the rain-fall of any district, two points have to be determined before the results are strictly comparable. The indications obtained by observation must be reduced to some common standard, both as regards the series of years during which observations have been made, and the elevation of the gauge above the surface of the ground.

It is a well-established fact, that the amount of rain registered by a gauge decreases inversely with the height above the ground. No very satisfactory explanations have hitherto been advanced for this singular phenomenon. Some attribute it to the action of the wind producing an eddy in the funnel of the gauge, whereby the rain is either swept out or prevented from entering; others suppose that the cold rain-drops in falling condense the circumambient vapour on their surface: but that recently proposed by Mr. Baxendell of Manchester seems the least objectionable; he imagines that particles of water which have lost the caloric of elasticity are capable of existing in the atmosphere in an invisible state, and that the rain-drops collect these in their fall. The fact of the decrease, however, is undisputed; and to obtain an approximation to the actual value, the records of the Meteorological Society, and the tables furnished by private observers, have been

called into requisition; the results are given in the last column of Table I., from which it will be seen that, taking the rain-fall at the surface of the earth as equal to 1000, at 50 feet above the ground it is 775. From this the values, given in the rain-table hereafter, are reduced to the ground level where the height of the receiver of the gauge is more than a foot above the surface.

The register at St. Thomas, Exeter, given in Table II., has been taken as the standard of time, to which all the others have been reduced, on the assumption that the ratio of the rain-fall for any particular year to this series does not materially differ at any of the stations.

As the fall of rain is greatly influenced by the contour of the land, it will not be out of place to give a slight sketch of the principal features of the county of Devon. In the north rises the high land of Exmoor, which extends for some distance along the coast, and branches off in a south-easterly direction along the borders of Somersetshire. The watershed of this mass is actually in Somerset, in which county the Exe rises; but many of the hills on the moor in Devonshire are from 1000 to 1500 feet in elevation. South-east of Exmoor, and separated from it by the vale of the Culm, are the Blackdown Hills, which form an elevated table-land varying from 700 to 900 feet; several spurs extend from this to the sea-coast at Sidmouth and the neighbourhood. Passing by the rich undulating lands near Exeter, the Haldon Hills, a few miles west of this city, run in a direction from N.N.W. to S.S.E.; they present the same features as the Blackdown, and are about 800 feet in height. Proceeding still to the S.W., the southern portion of the country is uneven, but the hills attain no great elevation.

Further to the north, the valley of the Teign separates the Haldon Hills from Dartmoor, by far the most prominent feature of the county. The great granite boss which goes under this name, and from which, with the exception of the Exe, the principal rivers of the county take their rise, extends about twenty-two miles from north to south, and varies in breadth from eighteen miles in the north to about nine in the south. To the north of the moor, Yes Tor rises to a height of 2050 feet; it is nearly equalled by several of the adjoining hills; in the south the higher eminences range from 1400 to 1800 feet. The average elevation of this wild but healthy district exceeds 1200 feet; it is almost entirely covered with irreclaimable bog and bare rocks called "Tors," and in every direction rapid streams are met with, which are very liable to sudden floods.

At the same geological period that Dartmoor was formed, the metalliferous slate district in the west was thrown up into ranges of hills, which are now well wooded, and attain a height of from 700 to 1000 feet.

From the north-western part of the moor, near Sourton, the ground gradually slopes away to Hartland Point, and divides the valley of the Tamar from the comparatively low lands which form the basin of the Taw and Okement, and which separate Dartmoor from Exmoor.

The watershed of the county is very nearly represented by an imaginary line, extending in a south-easterly direction from Hartland Point to Amicombe Hill on the north of Dartmoor, and from thence to Anstey Hill on Exmoor, towards the north-east.

Through the kindness of correspondents (among whom may be mentioned Mr. Treby of Goodamoor, Mr. Ellis and Dr. Shapter of Exeter), the author has been fortunate in securing returns of rain-fall from as many as forty-eight stations in Devon: the reductions to mean values applied in the manner previously indicated, and the concluded annual falls are given in Table III.

The order of arrangement commences with the stations on the southern slope of the watershed in the north-eastern part of the county, passing to the S.W., thence to the west, when crossing the line of watershed the stations near Barnstaple come in, and the series closes with North Tawton in the centre.

In Table IV. are given the average monthly fall and probable variation in the amount of rain for three stations where observations have been registered for a long series of years. The probable variation in the rain-fall is that difference from the mean within which it is an even chance that the amount will fall. If the deposit of rain in any year or month differs from the average by more than this, it may be considered wet or dry, as the case may be; if the difference is less, the period is of ordinary character, as far as regards rain-fall. The formula from which it is computed is represented by the expression

$$\sqrt{\frac{\Delta^2}{n-1}} . 0{\cdot}674,$$

where Δ^2 is the sum of the squares of the difference of the rain-fall in each month from the average, n the number of years of observation.

In reference to Table III., it must be borne in mind that, from the mode of reduction, any discrepancies that may arise from a disadvantageous position of the gauge will become evident: these

will principally occur in gauges at some height above the ground, where the action of the wind has a great effect in drifting the rain. For instance, at the Institution, Exeter (10), at 13 feet 7 inches, the concluded annual rain-fall is too small by 2 inches, the disturbing causes being a gauge from which there is evaporation, and a large holly-bush within 3 feet of it. In the High Street, Exeter (12), at 40 feet from the ground, the influence of the wind among the house-tops produces an excess of nearly 7 inches; and at Teignmouth (17) there is an apparent deficiency of 4 inches. It is from this very evident that not much reliance can be placed on observations unless the rain-gauge is perfectly exposed, and near the surface of the ground.

The stations may be grouped together as follows:—

Nos.		Rain in inches.
1–3.	Hills in the N.E.	43·55
4–13.	Vales and lowlands in the east	34·06
14–20.	South-east coast	33·82
21.	South coast	36·89
22.	East Dartmoor	74·31
23–28.	West Dartmoor	58·43
29–39.	Hills west of the Dartmoor range	44·96
40.	Exmoor	61·85
41, 42.	North-west coast	35·72
43–48.	Central Devon	40·46

Various theories have been advanced as to the cause of the increase of rain in hilly districts: one (the most commonly received) is, that a current of air saturated with vapour, on coming in contact with the cold hills has its vapour condensed, which falls in rain. This cannot, however, be so; if it were, we should invariably have rain when in the winter months a warm and saturated south-west wind succeeded a frost, as long as the ground remained unthawed, instead of a thin surface-fog, as usually obtains. In the autumn, too, after clear nights the dew-point temperature is often higher than that of the ground and pavement, under which circumstances we find the vapour condensed on the surface, which appears wet in consequence.

The true explanation may be thus illustrated. It must first of all be mentioned, that it has been found by observation and experiment that the temperature of the air decreases $1\frac{1}{4}°$ of Fahr. for every 100 yards of ascent, that of the dew-point $\frac{1}{4}°$; if then a stratum of air, in which the complement of the dew-point is

5° Fahr., be raised through a vertical space of 1200 feet, the vapour which it contains will begin to condense into cloud. Now, let us imagine a south-westerly surface wind to be setting in from the Atlantic, at a temperature of 52° and a dew-point 48°, as is frequently the case in the autumn and early winter. On reaching the land a ripple is produced, and in crossing the Dartmoor hills the whole stratum of air is lifted up about 1700 feet. In rising through this extent, the air expands and cools; at a height of 975 feet the cold produced by expansion will begin to condense the vapour into cloud, and all the hills above this elevation will be capped with fog, the temperature at this point being 48°; in a further ascent, the latent heat evolved by the process of condensation will prevent the air cooling as fast as it did to the extent of nearly three-fourths the amount; so that at 1700 feet the temperature will not be lower than 47°·3; under favourable circumstances, however, rain will ensue; on passing the hills, the mist sinks, becomes warmed under greater pressure, and evaporates.

The author was himself involved in a drizzling mist on the top of Great Links Tor, a hill nearly 2000 feet in height on the north-west side of the Moor, in August 1861, under similar circumstances. A strong S.S.W. wind was blowing, and at noon the tops of the higher hills were capped with cloud. On reaching the summit of the Tor shortly after, an instructive sight was presented to the eye. The particles of mist were swept up by the blast from the plain of condensation, carried over the summit of the Tor, and down on the other side, where they came under greater pressure and evaporated. The mist rapidly increased, the vapour plain descended, and the descent from the hill became a matter of great difficulty. During the remainder of the day rain fell in a thick drizzle. At Plymouth, which lay directly to windward, not a drop of rain fell, and the day was fine with much sunshine, and some cirrocumuli; and even at Tavistock, not eight miles off, there was only a slight shower. Often the Moor is enveloped in a thick fog for days together, rendering travelling impracticable.

A short inspection of Table IV. will suffice to show that the monthly fall of rain is above the average from October to January inclusive, below it during the remainder of the year.

The cause of this plentiful supply of rain in the autumnal months has not far to be sought. It is a well-known fact that at this time of the year the temperature of the waters of the Atlantic is much higher than that of our own shores in the same lati-

tude. Mr. Whitley, of Truro, found in 1849, from 146 observations at St. Agnes, Cornwall, that the temperature of the sea in the months of October, November, and December was respectively 1°·9, 3°·9, and 7°·4 higher than that of the air at Truro; and in the month of December he once observed the temperature of the air 20°, while the sea was never colder than 46°; he also states that in December the sea is usually about 6° warmer than the air, and that in the same latitude in the middle of the Atlantic the sea is 10° warmer than on our shores. It is plain, then, that when westerly winds prevail, the air must be nearly saturated with vapour, coming as it does into a comparatively cold climate, and the fall of rain is then larger than in summer, although the actual amount of vapour in the air is less. This is found to be the case at all maritime stations; among others may be mentioned Sandwick in Orkney, where observations have been taken by Mr. Clouston for many years.

Closely connected with the subject of vapour is that of the fall of rain at different heights above the ground, which has been previously referred to. A comparison of the 44 years' register of the monthly fall of rain at the Institution, Cathedral Yard, Exeter, and St. Thomas's Asylum, is calculated to throw some light on the question of the distribution of rain at various heights above the surface of the ground at the different seasons of the year. Although the gauges are nearly a mile apart, and that at St. Thomas's perhaps more liable from its lower situation to the influence of creeping mists from the river Exe, while the Institution gauge is not well placed, yet, as the errors are evenly distributed over the year, the results are inserted for comparison. From Table V. we learn that the stratum of air nearest the surface of the earth is highly charged with particles of water in the winter months; and if we assume that, of the 4·24 inches deficiency in the rain-fall at the Institution, 2·20 inches (0·183 per month) are due to the disadvantageous position of the gauge, and the remaining 2·04 inches to the greater height from the ground, it follows that in the summer there is but little difference in the amount of rain received at 3 feet and 13 feet 7 inches, the excess in favour of the lower gauge being barely 1 per cent. from April to September inclusive; and that during the six months, from October to March, the increase amounts to somewhat over 11 per cent.

TABLE I. Showing the amount of the observed Rain-fall at various heights above the ground, with the ratio deduced therefrom.

Station.	Length of time. yrs.	m.	Height of lower gauge above the ground. ft.	ins.	Height of upper gauge above the ground. ft.	ins.	Total rain-fall in the lower gauge. inches.	Total rain-fall in the upper gauge. inches.	Ratio of rain-fall in the upper to the lower gauge. Lower = 1000.
Jersey	3	9	......		8	0	114·6	114·9	1002
Hartwell Rectory	3	9	......		4	0	96·4	95·5	991
Newport..................	4	3	......		3	0	135·8	133·9	986
Holkham	7	3	......		4	0	200·3	185·2	924
Rose Hill	1	6	......		7	0	40·8	36·5	895
Greenwich	18	0	......		1	8	441·04	407·13	924
Allenheads	2	9	......		6	9	127·0	132·5	1044
Mean	....		......		4	11	......	......	966·6
St. Leonard's, Exeter..	1	0	......		20	0	31·4	26·3	837
Oxford	7	6	......		22	0	198·0	169·3	855
Nottingham	7	9	......		25	0	198·5	183·2	902
Greenwich	18	0	......		22	4	434·14	384·78	886
Mean	....		......		22	4	......	......	870·0
Cardington	6	0	......		36	0	144·3	116·6	808
Finchley Road	1	0	......		36	0	21·26	15·08	709
Norwich..................	7	6	......		31	0	200·7	183·1	912
Warrington	3	0	......		34	6	82·9	71·8	866
Mean	....		......		34	4·5	......	......	823·7
York	3	0	......		43	8	66·046	52·444	794
Clifton	8	3	......		50	0	250·8	223·4	891
Greenwich...............	13	0	......		50	8	298·54	169·7	559
Preston	10	0	1	0	53	6	336·01	289·32	861
Mean	....		......		49	5·5	......	.....	776·2

Height in feet above the ground.	Ratio of the rain-fall.
0	1000
1	993
2	986
3	979
4	972
5	965
6	958
7	951
8	945
9	939
10	933
11	927
12	921
13	916
14	911
15	906
16	901
17	896
18	891
19	886
20	881
21	876
22	871
23	867
24	863
25	859
26	855
27	851
28	847
29	843
30	839
31	835
32	831
33	827
34	824
35	820
36	817
37	813
38	810
39	807
40	804
41	801
42	798
43	795
44	792
45	789
46	786
47	783
48	780
49	778
50	775

Table II. Showing the mean Monthly and Annual Rain-fall at St. Thomas's Hospital, Exeter. (50 feet above the sea-level. Gauge 8 feet from the ground, diameter 1 foot.)

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1814.	3.54	.80	1.38	1.95	.10	2.76	1.30	.96	2.02	3.05	2.10	2.90	22.86
1815.	2.30	2.30	3.92	.70	3.60	2.60	.95	.70	1.85	5.24	1.90	2.20	28.26
1816.	3.34	1.95	2.81	1.00	1.33	1.67	5.36	2.30	1.28	1.82	3.39	7.34	33.59
1817.	4.42	1.23	1.98	.00	3.67	2.66	2.22	4.59	.44	1.12	2.79	4.13	29.25
1818.	3.60	3.94	5.78	6.33	1.56	.76	.80	.07	6.78	2.40	4.16	3.12	39.30
1819.	5.40	4.27	.27	2.42	3.55	2.25	2.40	2.20	2.64	2.31	2.74	4.35	34.80
1820.	3.68	1.38	.62	1.44	2.23	.57	1.05	2.17	2.42	5.68	1.62	2.49	25.35
1821.	2.83	.32	4.49	3.43	3.06	1.96	2.68	2.33	3.10	3.36	5.44	8.58	41.58
1822.	1.28	2.51	1.52	2.89	.57	.87	3.71	1.53	1.33	6.31	5.87	1.10	29.49
1823.	5.80	(4.61)	2.17	1.38	2.28	1.71	2.82	2.16	1.10	7.17	1.91	4.68	37.79
1824.	.90	2.06	2.83	3.44	2.65	2.63	1.49	1.57	2.30	5.65	5.28	4.66	35.46
1825.	2.50	2.15	2.98	2.15	2.53	1.18	.00	1.29	2.79	4.03	2.85	4.27	28.72
1826.	2.30	4.23	2.67	.88	1.99	.35	1.08	2.50	5.29	3.40	2.36	3.48	30.53
1827.	1.97	1.14	4.07	1.68	2.92	1.11	1.47	2.29	4.15	6.02	2.37	4.04	33.23
1828.	5.41	3.30	1.25	3.81	3.27	3.63	4.50	2.59	3.42	2.21	3.09	3.93	40.41
1829.	2.02	1.64	2.46	5.92	.79	4.58	5.61	2.69	5.43	1.21	1.03	.71	34.09
1830.	2.14	.92	.83	2.93	2.56	3.61	2.26	3.07	3.29	.50	5.55	5.05	32.71
1831.	3.11	3.12	2.33	2.95	1.49	.95	2.17	1.80	2.17	5.52	3.49	5.78	34.88
1832.	1.31	.84	2.62	1.20	1.81	2.32	1.54	5.10	.38	4.00	5.72	3.37	30.21
1833.	2.01	7.81	1.76	3.44	.62	5.11	.77	.60	1.98	3.34	3.15	4.66	35.25
1834.	7.08	1.70	.81	.97	1.23	2.95	3.30	2.13	1.96	1.25	2.23	1.04	26.65
1835.	1.73	3.23	3.24	1.17	2.55	1.78	.59	2.08	4.02	5.78	4.48	.93	31.58

1836.	3·47	1·65	4·90	2·74	1·17	1·98	2·08	·74	3·49	4·24	6·55	3·17	36·18
1837.	2·18	4·07	1·36	1·61	1·20	1·47	2·15	4·19	2·87	1·70	2·50	2·33	27·63
1838.	1·66	5·39	2·64	1·61	2·89	4·01	1·35	1·85	1·57	3·58	10·26	2·18	38·99
1839.	2·18	1·71	2·72	1·78	1·25	5·39	4·51	2·02	4·16	4·81	5·44	5·12	41·09
1840.	4·97	3·85	·06	·40	1·60	·78	1·58	1·29	1·93	2·16	6·61	·78	26·01
1841.	3·93	2·76	3·25	2·24	2·80	2·38	2·07	2·52	6·21	4·08	6·46	4·20	42·90
1842.	4·29	2·29	3·18	·54	1·44	1·27	1·45	3·78	2·23	1·58	7·63	1·71	31·39
1843.	4·50	3·80	1·55	4·46	4·77	3·01	1·37	2·90	1·28	5·94	3·92	·82	38·32
1844.	2·77	2·92	3·15	·37	·10	1·53	1·37	3·08	1·54	3·33	3·83	3·63	27·62
1845.	3·62	2·03	·45	1·04	1·64	2·29	1·73	2·38	4·23	2·10	4·63	3·02	29·16
1846.	3·59	1·79	2·55	4·31	3·27	1·16	5·10	2·24	1·94	5·33	3·51	1·15	35·94
1847.	3·14	1·90	3·54	2·51	2·17	1·53	1·42	·97	·48	7·50	2·93	5·50	33·59
1848.	2·82	4·47	3·35	4·92	1·17	3·29	1·68	3·74	4·56	3·18	1·55	6·04	40·77
1849.	2·21	1·49	·99	2·58	2·60	·81	2·62	·87	3·42	2·54	2·54	4·09	26·76
1850.	2·40	1·55	·74	4·11	2·29	2·60	2·00	2·31	4·74	1·98	3·23	2·87	30·82
1851.	5·84	·63	5·00	2·20	1·43	1·09	2·07	1·87	·80	2·66	2·28	2·38	28·25
1852.	6·67	·80	1·18	1·36	2·49	4·25	·52	6·29	3·24	4·91	8·53	6·93	47·17
1853.	2·84	2·95	1·54	2·46	2·41	2·74	2·19	2·23	1·83	4·39	2·70	2·21	30·49
1854.	3·03	·66	·34	·22	2·24	2·49	3·62	1·34	·45	3·33	1·74	2·84	22·30
1855.	·00	2·40	2·42	·53	2·74	3·37	4·14	1·35	1·03	3·59	·89	2·80	25·26
1856.	4·95	2·59	2·42	3·43	3·13	·99	1·60	2·40	3·66	2·69	·30	5·13	33·29
1857.	2·30	2·46	4·48	3·97	3·29	2·06	1·33	·45	1·76	6·17	1·46	·93	30·66
1858.	·45	2·83	1·00	5·20	·63	1·52	3·17	·70	2·92	2·49	4·14	3·97	29·02
1859.	2·15	2·48	1·66	3·42	1·32	2·39	1·39	2·03	3·72	5·58	4·75	3·39	34·28
1860.	5·11	1·36	3·48	1·25	4·57	8·04	1·90	2·26	1·78	1·61	4·68	6·13	42·17
	3·186	2·474	2·357	2·368	2·148	2·350	2·181	2·181	2·680	3·678	3·757	3·535	32·895

TABLE III. Showing the observed and concluded

Station.	Height of gauge above the sea.	Height of gauge above the ground.	Years of observation.
No.	feet.	ft. in.	
1. Huntsham Court, Bampton	584	1 3	1859–60
2. Tiverton, Hayne	500	0 0	1854–60
3. Otterhead	......	....	1856–59
4. Honiton	......	....	1841–45
5. Broad Hembury	300	2 4	1837–60
6. Clyst Hydon	150	....	1847–60
7. Sidmouth	......	40 0	(1846–50)?
8. Sidmouth	......	....	1852
9. Exeter, St. Thomas's Hospital	50	3 0	1814–60
10. Exeter, D. and E. Institution	155	13 7	1817–60
11. Exeter, Barnfield	146	3 9	1848–57
12. Exeter, High Street	170	40 0	1854–60
13. Exeter, Pen Leonard	......	1 6	1840–42
14. Mamhead	......	....	1852–53
15. Dawlish	......	....	1859–60
16. Teignmouth	25	0 3	1860
17. Teignmouth	64	1 1	1855–59
18. Torquay	120	6 0	1852–53, 1860
19. High Wick	300	1 6	1851–52, 1854–57, 1860
20. Bovey Tracy	100	0 6	1852, 1857–60
21. The Gnoll, Kingsbridge	143	0 6	1857–60
22. Holne Vicarage	630	1 0	1851–56
23. Goodamoor	600	....	1840–60
24. Lee Moor, Shaugh	900	....	....
25. Sheep's Tor, Burrator	950	....	1855–58
26. Prince Town	1360	....	1840–41
27. Dartmoor Prison	1380	40 0	1854–60
28. Rough Tor Consols	1200	....	1856
29. Tor Hill, Ivy-Bridge	260	0 4	1858–60
30. Ridgway Hill, Plympton St. Mary	116	....	1857–60
31. Saltram	96	0 3	1856, 1858–60
32. Devonport	58	38 0	1844, 1852
33. Plymouth	30	20 0?	1826–35
34. St. Budeaux, Ham	80	......	1847–48, 1850–52, 1854–60
35. Buckland Monachorum, Crapstone	500	....	1857–58, 1860
36. Tavistock Library	298	45 0	1844–60
37. South Sydenham	......	....	1858
38. Edgcumbe	......	0 8	1859–60
39. Bradstone	......	....	1840, 1842
40. Westland Pound, Kentisbury	930	1 10	1855
41. Appledore, Taw Lighthouse	......	25 0?	1855
42. Braunton	40	....	1855–56
43. Barnstaple	......	....	1858–59
44. Barnstaple	31	0 6	1857–60
45. South Molton, Castle Hill	160	3 0	1852–60
46. Chawleigh	......	....	1857–59
47. Witheridge	......	....	1855
48. North Tawton	450	35 0	1856

Annual Rain-fall at 48 Stations in Devonshire.

Number of years.	Ratio of the rain-fall at St. Thomas's, Exeter, 1814–1860=1000.	Mean observed rain-fall.	Correction for elevation of the gauge above the ground.	Mean rain-fall corrected for elevation.	Reduction to the St. Thomas's series, 1814–60.	Concluded mean annual rain-fall.
		inches.	inches.	inches.	inches.	inches.
2	1162	53·69	+ ·49	54·18	− 7·55	46·63
7	942	38·17	·00	38·17	+ 2·35	40·52
4	967	42·05	....	42·05	+ 1·44	43·49
5	1036	33·20	....	33·20	− ·97	32·23
24	1006	34·71	·60	35·31	− ·21	35·10
14	988	32·52	·26	32·78	+ ·40	33·18
5	1021	27·91	6·80	34·71	− ·71	34·00
1	1434	51·03	....	51·03	−15·44	35·59
47	1000	32·89	·71	33·60	....	33·60
44	1010	28·97	2·77	31·74	− ·31	31·43
10	960	29·41	·82	30·23	+ 1·26	31·49
7	942	30·52	7·44	37·96	+ 2·34	40·30
3	1016	33·84	·37	34·21	− ·54	33·67
2	1180	42·35	....	42·35	− 6·46	35·89
2	1162	37·11	....	37·11	− 5·18	31·93
1	1282	40·35	....	40·35	− 8·88	31·47
5	927	25·30	·18	25·48	+ 2·01	27·49
3	1214	40·42	1·77	42·19	− 7·44	34·75
7	995	35·40	·39	35·79	+ ·18	35·97
5	1114	43·74	....	43·74	− 4·48	39·26
4	1035	38·18	....	38·18	− 1·29	36·89
6	946	69·81	·49	70·30	+ 4·01	74·31
21	993	55·81	....	55·81	+ ·40	56·21
...	......	......	....	......	....	60·83
4	899	48·83	....	48·83	+ 5·49	54·32
2	1048	58·55	....	58·55	− 2·68	55·87
7	942	47·58	11·60	59·18	+ 3·64	62·82
1	1020	61·03	....	61·03	− 1·20	59·83
3	1069	47·38	....	47·38	− 3·06	44·32
4	1107	47·36	....	47·36	− 1·60	45·76
4	1055	42·17	....	42·17	− 2·20	39·97
2	1014	33·55	7·87	41·42	− ·57	40·85
10	1002	35·70	4·82	40·52	+ ·04	40·48
12	1007	46·42	....	46·42	− ·32	46·10
3	1032	50·64	....	50·64	− 1·57	49·07
17	979	37·44	10·01	47·45	+ 1·02	48·47
1	882	47·36	....	47·36	+ 6·34	53·70
2	1162	54·29	....	54·29	− 7·57	46·72
2	872	34·13	....	34·13	+ 5·01	39·14
1	768	46·88	·62	47·50	+14·35	61·85
1	768	24·24	3·98	28·22	+ 8·52	36·74
2	890	31·79	....	31·79	+ 3·91	35·70
2	962	41·00	....	41·00	+ 1·62	42·62
4	1035	41·00	....	41·00	− 1·39	39·61
9	995	41·20	·88	42·08	+ ·21	42·29
3	952	37·73	....	37·73	+ 1·90	39·63
1	768	31·08	....	31·08	+ 9·39	40·47
1	1020	31·88	7·00	38·88	− ·76	38·12

There are frequently very heavy falls of rain in the hilly districts. The most remarkable was that which occurred at Huntsham Court on July 1st, 1857, when, between 3^h and 7^h P.M., *i.e.* in 4 hours, 3·87 inches of rain fell: this is probably the heaviest fall in so short a space of time that has been recorded in the south of England. At Holne, in January 1851, 4·17 inches fell on the 20th, and in November 1852, 3·91 inches fell during the night of the 6th. In the low country at Clyst Hydon there fell of rain, in 29 hours on the 6th and 7th of October 1847, 3·04 inches; three days afterwards there was an additional fall of 1·06 inch. Again, on July 10th, 1854, during a severe thunder-storm, there fell 1·42 inch in 1^h 20^m.

Devonshire, in common with the rest of England, is occasionally subject to drought.

In the three months ending April 1854, there fell only 1·56 inch of rain at Clyst Hydon, and at St. Thomas's 1·22 inch. At Holne Vicarage, where in the year 1852 the fall of rain was 102·53 inches, the amount collected during the same period was 4·26 inches.

Want of space forbids a further consideration of this question, or of instituting a comparison between the rain-fall in Devonshire and that in other parts of Great Britain; those who wish to pursue the subject may consult the copious information contained in Mr. Beardmore's "Hydraulic Tables," now in the press.

TABLE IV. Showing the Mean Monthly Fall of Rain and probable Variation at St. Thomas's, 50 feet above the Sea; Broad Hembury, 300 feet; and Goodamoor, 600 feet above the sea.

	St. Thomas's, Exeter.		Broad Hembury.		Goodamoor*.	
	Monthly fall.	Probable variation.	Monthly fall.	Probable variation.	Monthly fall.	Probable variation.
	inches.	inches.	inches.	inches.	inches.	inches.
January	3·18	1·05	3·07	·94	6·09	1·66
February	2·47	·92	2·48	·69	4·04	1·13
March	2·36	·92	2·07	·89	3·68	1·50
April	2·37	1·04	2·55	1·04	3·93	1·65
May	2·15	·73	2·41	·76	3·75	1·15
June	2·35	·99	2·99	1·09	4·11	1·76
July	2·18	·88	2·56	·74	3·78	·94
August	2·18	·82	2·93	·95	4·22	1·34
September	2·68	1·03	2·68	1·05	4·41	1·64
October	3·68	1·20	4·05	1·18	5·94	1·63
November	3·76	1·37	3·89	1·64	6·37	2·47
December	3·53	1·25	3·03	1·10	5·49	1·73
Year	32·89	3·83	34·71	4·64	55·81	6·48
Monthly fall	2·74	....	2·89	....	4·65	

* At Goodamoor, from 1840–1860, the average number of days in the year on which rain fell was 215·6. Probable variation 14·7.

TABLE V. Comparison of the Rain-fall at the Institution, Cathedral Yard, Exeter, 13 feet 7 inches above the ground, and at St. Thomas's Asylum, Exeter, 3 feet above the ground.

Month.	Average fall of rain from 1817 to 1860 inclusive.		Excess of rain at St. Thomas'	Ratio of the rain-fall in each month to the average monthly fall.		Higher ratio at St. Thomas'
	Institution, 13 feet 7 inches above the ground, 155 feet above the sea.	St. Thomas's, 3 feet above the ground, 50 feet above the sea.		Institution.	St. Thomas'	
	inches.	inches.	inches.			
January	2·604	3·195	+0·591	1079	1154	+75
February ...	1·991	2·528	·537	824	914	+90
March	1·970	2·333	·363	816	843	+27
April	2·155	2·447	·292	893	884	− 9
May	1·970	2·181	·211	816	788	−28
June	2·196	2·350	·154	910	849	−61
July	1·943	2·156	·213	805	779	−26
August	2·189	2·240	·051	907	810	−97
September ...	2·456	2·746	·290	1017	992	−25
October	3·257	3·698	·441	1349	1336	−13
November ...	3·360	3·845	·485	1392	1389	− 3
December ...	2·881	3·493	·612	1192	1262	+70
Total	28·972	33·212	4·240	......	......	......
Average	2·414	2·768	·354	1000	1000	00

II. *On the Direction of the Wind at the Royal Observatory, Greenwich, in the Twenty Years ending December* 1860. By JAMES GLAISHER, Esq., F.R.S., Secretary to the British Meteorological Society.

I BELIEVE up to the present time there has not been any satisfactory discussion upon the direction of the wind, nor have any safe results been deduced as to the average duration, in the year, of the winds from different quarters, and their average distribution over the several months of the year; neither has it been shown whether the more or less frequency of any or of all winds followed any period or cycle.

In my investigation upon the temperatures of the last ninety years, I have frequently felt that I was investigating an effect, the cause of which must in a great measure have been the quarter from which the wind blew; and in my paper in the 'Philosophical Transactions,' published in part 2, 1850, on the monthly temperature of the preceding seventy-nine years, I stated that "The numbers in the preceding Tables very clearly show that causes exist at

different times, which raise or depress the temperature, and which continue through long periods." The main cause I then thought was the more or less continuance of cold or warm winds; and with the view of determining, if possible, how far the monthly temperatures had been influenced by the wind, I extracted and arranged every observation of the direction of the wind, with its strength, for all these seventy-nine years; but although the result was an indication of connexion, yet it was by no means such as I could announce or use. The data were insufficient; the recorded winds were those which the observer considered the prevailing wind, and noticed twice only in the day, separated for the most part by a few hours only. Since the year 1850 I have been more and more convinced of the necessity of investigating the direction of the wind at successive periods; and in the present state of meteorology, with a tolerable knowledge of the daily, monthly, and yearly temperatures and pressure of the air, I think the phenomena of the winds the most important to investigate.

This investigation, however, to be of any value, must proceed upon a totally different principle from that which has hitherto been in use, viz. using the prevailing direction, to the neglect of all other directions; instances of this I shall have to speak of presently; and instead of this partial method, to give to all due weight, and determine, as in all other meteorological elements, the average direction.

For the most part, another cause of our want of knowledge has been the almost utter neglect of night observations. At the Royal Society, for instance, the observations were taken at 9 A.M. and 3 P.M., neglecting entirely the remaining eighteen hours; and it is evident that the knowledge we are seeking must be based upon night observations as well as those of the day, and therefore, to be done effectually, must be done mechanically by an instrument. The wind, in fact, must be made to record its own direction, its own strength, and its own velocity; it is, in fact, necessary to use an anemometer.

In the year 1841 Osler's anemometer was erected at Greenwich Observatory, and ever since has been placed under my superintendence; last year completed twenty years, an interval of considerable length, and from which some safe results may probably be deduced; and it is almost solely upon the results from these self-registering records, as published in the Greenwich Observations, I have based the following investigation.

The first step in the work was to extract from the sheets the

direction of the wind at every hour; thus we had twenty-four directions in the day, between midnight and midnight.

The next step was to take the mean of these twenty-four directions, and consider it as the true mean direction of the wind for the day; and in this way twenty Tables were formed, showing the mean direction of the wind at Greenwich, on every day from 1841 to 1860.

From these twenty Tables, the next process was collecting all those days in each month when the air had passed from one of the eight points of the azimuthal compass; when it had blown, at any part of the day, with a pressure equal to or greater than ¼ pound on a square foot of surface, exposed at right angles to the direction of the wind. All the remaining days, including all those when the pressure at all times of the day was less than ¼ pound, have been considered as days of so gentle motion (particularly as during some portion of every one of them the air has been in a quiescent or almost a quiescent state) that I have classed them as calms; but it must be clearly understood that I do not profess them as calm days, for I believe there is scarcely upon the average one absolute calm day in the year.

On some days the average direction has not been exactly from one of the sixteen points, but has been intermediate between two of them; in such cases, if only one such appeared in the month, I have referred it to one of the adjacent points; and when two or more of the same direction, I have referred one-half the number to each of the adjacent points; and in this way a second series of twenty Tables was formed, containing the number of days the average direction of the wind was from each of the points of the azimuthal circle, when divided into eight parts; the sum of all the directions, with the calms, making up the number of days in every month.

The next process was the reduction of all these results to the four cardinal points, forming another series of Tables.

From these results the prevailing wind for every month was determined, and which are contained in Table I.

TABLE I. Showing the prevailing Direction of the Wind at Greenwich, in every Month from January 1841 to December 1860.

Years.	Months.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1841.	S.W.	S.E.	S.W.	N.W.	S.W.	S.W.	S.W.	S.W.	S.W.	S.W.	S.W.	S.W.
1842.	S.W.	S.W.	S.W.	N.E.	S.W.	S.W.	S.W.	S.E., S.W.	N.W.	N.W.	S.W., N.W.	S.W.
1843.	S.W.	N.E.	N.E.	S.W.	S.W.	N.W.	S.W.	S.W.	N.E.	S.W.	S.W.	S.W.
1844.	S.W.	S.W.	N.W., S.W.	S.W.	N.E.	N.W.	S.W.	S.W.	N.W.	S.W.	S.W.	N.E.
1845.	S.W.	N.W.	N.E., N.W.	N.E., S.W.	N.W.	S.W.	S.W.	S.W.	S.W.	S.W.	S.W.	S.W.
1846.	S.W.	S.W.	S.W.	variable	S.W.	S.W.	N.W.	N.W.	N.E.	S.W.	S.E.	S.W.
1847.	S.E.	S.W.	S.W.	S.W.	S.	S.W.	S.W.	S.W.	S.W.	S.W.	S.W.	S.W.
1848.	N.E.	S.E.	S.W.	N.E.	N.E.	S.W.	S.W.	S.W.	N.W.	S.	S.W., N.W.	S.E.
1849.	S.W.	S.W.	N.W.	N.W., S.W.	N.W.	N.E.	S.W.	S.W.	N.E.	variable	variable	N.W.
1850.	N.E.	S.W.	N.	S.W.	N.E.	S.E., S.W.	S.W.	S.W.	N.E.	S.W., N.W.	S.W., N.W.	S.W.
1851.	S.W.	S.W.	S.W.	variable	N.	W.	S.W., N.W.	S.W., N.W.	N.E.	S.W.	N.W.	S.W.
1852.	S.W.	N.W.	N.E.	E.	N.W.	S.W.	N.E., S.E.	S.W.	N.E., N.W.	S.W.	S.	S.W.
1853.	S.W.	N.E.	N.E.	N.W.	N.E.	N.W., S.W.	S.W.	variable	S.W., N.W.	S.W.	S.W.	N.E.
1854.	S.E., S.W.	S.E., S.W.	S.W.	N.E.	S.W.	S.W.	S.W.	S.W.	S.W., N.W.	S.W., N.W.	S.W., N.W.	W.
1855.	N.E., N.W.	N.E.	N.E.	N.E.	N.E.	S.W.	S.W.	S.W.	N.E.	N.W.	N.E.	N.W.
1856.	S.W.	S.W.	N.E.	S.E.	N.W.	N.W., S.W.	W.	S.W.	S.W.	N.E.	N.W.	N.W., S.W.
1857.	N.W.	S.W.	S.W.	S.W.	N.E.	S.E.	S.W.	S.W.	S.W.	S.W.	N.E.	S.W.
1858.	S.W.	S.E.	N.W.	N.E.	S.W.	S.W.	S.W.	variable	S.W.	S.W.	N.E.	S.W.
1859.	S.W.	S.W.	S.W.	S.W.	N.E.	N.E., N.W.	S.W.	S.W.	S.W.	S.W.	S.W.	S.W.
1860.	S.W.	N.W.	W.	N.E., N.W.	S.W.	S.W.	N.W.	S.W.	S.W.	S.W.	N.E.	N.W., N.E.

By collecting these several prevailing directions together in each year, we learn that the prevailing direction of the wind was—

In the year 1841:—
S.W. for 10 months.
N.W. for 1 month.
S.E. for 1 month.

In the year 1842:—
S.W. for 8 months.
N.W. for 2½ months.
N.E. for 1 month.
S.E. for ½ month.

In the year 1843:—
S.W. for 8 months.
N.W. for 1 month.
N.E. for 3 months.

In the year 1844:—
S.W. for 7½ months.
N.W. for 2½ months.
N.E. for 2 months.

In the year 1845:—
S.W. for 8½ months.
N.W. for 2½ months.
N.E. for 1 month.

In the year 1846:—
S.W. for 8 months.
N.W. for 1 month.
N.E. for 1 month.
S.E. for 1 month.
Variable for 1 month.

In the year 1847:—
S. for 1 month.
S.W. for 10 months.
S.E. for 1 month.

In the year 1848:—
S. for 1 month.
S.W. for 4½ months.
N.W. for 1½ month.
S.E. for 2 months.
N.E. for 3 months.

In the year 1849:—
S.W. for 4½ months.
N.W. for 3½ months.
N.E. for 2 months.
Variable for 2 months.

In the year 1850:—
S.W. for 5½ months.
N.W. for 2 months.
N.E. for 3 months.
S.E. for ½ month.

In the year 1851:—
S. for 1 month.
S.W. for 6 months.
W. for 1 month.
N.W. for 2 months.
N. for 1 month.
Variable for 1 month.

In the year 1852:—
S. for 1 month.
S.W. for 5 months.
N.W. for 2½ months.
N.E. for 2 months.
S.E. for ½ month.
E. for 1 month.

In the year 1853:—
S.W. for 5 months.
N.W. for 2 months.
N.E. for 4 months.
Variable for 1 month.

In the year 1854:—
S.W. for 7½ months.
W. for 1 month.
N.W. for 1½ month.
N.E. for 1 month.
S.E. for 1 month.

In the year 1855:—
S.W. for 3 months.
N.W. for 2½ months.
N.E. for 6½ months.

In the year 1856:—
S.W. for 5 months.
W. for 1 month.
N.W. for 3 months.
N.E. for 2 months.
S.E. for 1 month.

In the year 1857:—
S.W. for 8 months.
N.W. for 1 month.
N.E. for 2 months.
S.E. for 1 month.

In the year 1858:—
S.W. for 7 months.
N.W. for 1 month.
N.E. for 2 months.
S.E. for 1 month.
Variable for 1 month.

In the year 1859:—
S.W. for 10 months.
N.W. for ½ month.
N.E. for 1½ month.

In the year 1860:—
S.W. for 6 months.
W. for 1 month.
N.W. for 3 months.
N.E. for 2 months.

From these we find that the *prevailing direction of the wind from the year* 1841 *to* 1847 *was*—

S.W. for 8½ months.
N.W. for 1½ month.
N.E. for 1 month in each year.

And there was no instance of the prevailing wind from the N., W., or E. in those years during any one month.

That from *the year* 1848 *to the year* 1856—

The S.W. wind prevailed for 4 or 5 months generally.
In 1851 it was prevalent for 6 months.
In 1854 it was prevalent for 7½ months.
In 1855 it was prevalent for 3 months only.

Whilst the N.W. wind prevailed from 2 to 3 months.
N.E. wind prevailed from 2 to 3 months.
N.E. wind in 1853 prevailed for 4 months.
N.E. wind in 1855 prevailed for 6½ months.

And the N. wind was prevalent occasionally for 1 month in the years 1851 and 1853.

From *the year* 1857 *to the end of the series*—

The S.W. wind has prevailed for 8 months in the year on an average.
In the year 1859 it prevailed for 10 months.
The N.W. wind has been prevalent for about 1 month.
The N.E. wind has been prevalent for about 2 months.

And in no instance has the N. wind been prevalent for any month; we therefore seem to be passing through a period very similar in its characteristics to those at the beginning of the series.

These results are interesting as indicating a marked difference in the direction of the wind in the years 1848 to 1856 from those immediately preceding 1848 and following 1856; but still they are very deceptive, and of no practical value, because they are based upon the prevailing winds, to the neglect of all others. For instance, let us take the first month of the series, viz. January 1841; in this month the prevailing direction of the wind was—

5 days from the N.
3 days from the N.E.
2 days from the E.

1 day from the S.E.
2 days from the N.W.
1 day calm.

In all 14 days neglected, and not allowed to exercise any weight. If we consider the most prevalent wind alone, this wind, viz. the S.W., was the most prevalent in 10 months of the year 1841; and if all the months were of the same character, 140 days in the year would not be allowed to exercise any influence if treated in this way alone.

I shall therefore make no further use of the preceding results, so far as prevailing winds are concerned, but proceed to give due weight to every wind; for this purpose I have taken the sums of the numbers in every year of every wind referred to eight points of the compass and formed Table II., containing the number of days of mean direction of the wind in different points in each year.

TABLE II. Showing the number of the Days of the Wind, during each of the years 1841 to 1860, referred to eight points of the Azimuthal Circle, and reduced to the four Cardinal Points.

Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	40	19	22	9	49	112	60	17	37	58½	36	110	123½
1842.	46	40	31	15	31	112	38	25	27	78½	58½	94½	106½
1843.	42	44	22	8	18	102	37	29	63	77½	49	76	99½
1844.	48	57	18	14	22	89	35	26	57	89½	53½	73½	92½
1845.	30	49	11	13	43	104	43	38	34	73½	42	100½	115
1846.	27	25	20	18	39	94	30	22	86	50½	41½	95	88
1847.	41	23	16	4	55	111	36	10	69	57½	29½	112½	96½
1848.	53	38	19	36	58	90	29	20	23	82	56	121	84
1849.	59	54	20	23	39	102	35	22	11	97½	58½	101	97
1850.	49	48	24	21	30	116	27	19	31	82½	59½	97½	94½
1851.	52	39	21	20	28	100	37	25	43	84	52½	86	99½
1852.	45	58	36	21	52	108	27	8	11	78	75½	116½	85
1853.	43	65	16	27	28	86	32	27	41	89	62	84½	88½
1854.	31	45	17	20	30	117	42	30	33	68½	49½	98½	115½
1855.	56	74	23	17	25	84	30	26	30	105½	70	77	82½
1856.	44	54	27	30	31	80	50	26	24	84	69	86	103
1857.	21	58	28	27	33	119	34	21	24	60½	70½	106	104
1858.	26	61	38	27	26	106	40	29	12	71	82	92½	107½
1859.	31	54	16	29	25	128	40	31	11	73½	57½	103½	119½
1860.	30	47	26	19	22	120	64	31	7	69	59	91½	139½

The numbers in this Table under each direction differ very much from each other:—

The N. wind numbered......	21 days in 1857. 59 days in 1849.
The N.E. wind numbered ...	19 days in 1841. 74 days in 1855.
The E. wind numbered	11 days in 1845. 38 days in 1858.
The S.E. wind numbered ...	4 days in 1847. 36 days in 1848.
The S. wind numbered	18 days in 1843. 58 days in 1848.
The S.W. wind numbered...	80 days in 1856. 128 days in 1859.
The W. wind numbered......	27 days in 1850 and 1852. 64 days in 1860.
The N.W. wind numbered...	8 days in 1855. 38 days in 1844.
Calm days numbered	7 days in 1860. 86 days in 1846.

By taking the mean of these numbers in each column, we find that from the 20 years' observations, the

Average number of days of Wind in the year with mean direction

N. was 40·70 days.
N.E. was 47·60 days.
E. was 22·55 days.
S.E. was 19·90 days.
S. was 34·20 days.
S.W. was 104·00 days.
W. was 38·30 days.
N.W. was 24·10 days.
Calm was 33·70.

And if we take the difference between these numbers and those of each year, we shall determine the departure in every year from the average direction of each wind, and these values are shown in the next Table.

TABLE III. Showing the number of days of departure of each Wind in every year, 1841 to 1860, from the average.

Years.	Number of days of departure in each direction of the Wind from average.									Resolved number of days of departure from average.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	− 1	−29	− 1	−11	+15	+ 8	+22	− 7	+ 3	−18	−21	+14	+22
1842.	+ 5	− 8	+ 8	− 5	− 3	+ 8	0	+ 1	− 7	+ 2	+ 2	− 1	+ 5
1843.	+ 1	− 4	− 1	−12	−16	− 2	− 1	+ 5	+29	+ 1	− 8	+20	− 2
1844.	+ 7	+ 9	− 5	− 6	−12	−15	− 3	+ 2	+23	+13	− 3	+22	− 9
1845.	−11	+ 1	−12	− 7	+ 9	0	+ 5	+14	0	− 3	−15	+ 4	+13
1846.	−14	−23	− 3	− 2	+ 5	−10	− 8	− 2	+52	−26	−16	− 1	−14
1847.	0	−25	− 7	−16	+21	+ 7	− 2	−14	+35	−19	−27	+17	− 5
1848.	+12	−10	− 4	+16	+16	−14	− 9	− 4	−11	+ 5	− 1	+25	−18
1849.	+18	+ 6	− 3	+ 3	+ 5	− 2	− 3	− 2	−23	+21	+ 2	+ 5	− 5
1850.	+ 8	0	+ 1	+ 1	− 4	+12	−11	− 5	− 3	+ 6	+ 3	+ 2	− 7
1851.	+11	− 9	− 2	0	− 6	− 4	− 1	+ 1	+ 9	+ 7	− 4	−10	− 2
1852.	+ 4	+10	+13	+ 1	+18	+ 4	−11	−16	−23	+ 1	+19	+21	−17
1853.	+ 2	+17	− 7	+ 7	− 6	−18	− 6	+ 3	+ 7	+12	+ 5	−11	−13
1854.	−10	− 3	− 6	0	− 4	+13	+ 4	+ 6	− 1	− 8	− 7	+ 3	+14
1855.	+15	+26	0	− 3	− 9	−20	− 8	+ 2	− 4	+29	+13	−19	−19
1856.	+ 3	+ 6	+ 4	+10	− 3	−24	+12	+ 2	−10	+ 7	+12	−10	+ 1
1857.	−20	+10	+ 5	+ 7	− 1	+15	− 4	− 3	−10	−16	+13	+10	+ 2
1858.	−15	+13	+15	+ 7	− 8	+ 2	+ 2	+ 5	−22	− 6	+25	− 3	+ 6
1859.	−10	+ 6	− 7	+ 9	− 9	+24	+ 2	+ 7	−23	− 3	+ 1	+ 8	+18
1860.	−11	− 1	+ 3	− 1	−12	+16	+26	+ 7	−27	− 8	+ 2	− 4	+37

The sign + denotes more than the average, and the sign − less than the average.

In this Table we see that in some years the departures from the averages have been great.

The following are the extreme departures in excess and defect:—

In 1849 the N. was 18 days in excess.
1857 the N. was 20 days in defect.
1855 the N.E. was 26 days in excess.
1841 the N.E. was 29 days in defect.
1858 the E. was 15 days in excess.
1845 the E. was 12 days in defect.
1848 the S.E. was 16 days in excess.
1847 the S.E. was 16 days in defect.
1847 the S. was 21 days in excess.
1843 the S. was 16 days in defect.
1859 the S.W. was 24 days in excess.
1856 the S.W. was 24 days in defect.
1860 the W. was 26 days in excess.
1850 and 1852 the W. was 11 days in defect.
1845 the N.W. was 14 days in excess.
1852 the N.W. was 16 days in defect.
1846 Calm was 52 days in excess.
1860 Calm was 27 days in defect.

It is to be remarked that for the most part those years thus distinguished belong to groups of three or four + or − signs coming together in successive years, and perhaps the most remarkable feature in Table III. is the fact of so many groups occurring of + and − signs.

By reducing the numbers in the first part of Table II. to the four cardinal points, forming the second part of the same Table, in each year, and taking their means, we find that for 20 years

The average number from N., as found from N. and its compounds, is 76·6 days.

The average number from S., as found from S. and its compounds, is 96·0 days.

The average number from E., as found from E. and its compounds, is 56·6 days.

The average number from W., as found from W. and its compounds, is 102·0.

And these, together with 33·7 calms, make up the entire year.

By taking the difference between these numbers and the corresponding numbers of each year, we shall determine the departure from the average of each wind in every year, and in this way the second part of Table II. has been determined.

From these numbers we learn that—

In 1855 the N., as found from itself and compounds, was 29 days in excess.

In 1846 the N., as found from itself and compounds, was 26 days in defect.

Therefore in 1855 there were 55 days of N. wind more than in 1846.

In 1858 the E., as found from itself and compounds, was 25 days in excess.

In 1847 the E., as found from itself and compounds, was 27 days in defect.

Therefore in 1858 the E. wind numbered 52 days more than in the year 1847.

In 1848 the S., as found from itself and compounds, was 25 days in excess.

In 1855 the S., as found from itself and compounds, was 19 days in defect.

Therefore in 1848 the S. wind numbered 44 days more than in 1855.

In 1860 the W., as found from itself and compounds, was 37 days in excess.

In 1855 the W., as found from itself and compounds, was 19 days in defect.

Therefore the W. in 1860 numbered 56 days more than in 1855.

This part of Table III. indicates by its groups of signs a period of some years' duration, during which there is an excess or deficiency of certain winds.

The results in the second part of Table III. have been laid down in diagrams, in which this periodic departure is better shown.

The inner circle of the four diagrams is laid down with a radius of 50 days, and the outer circle with a radius corresponding to that of the average continuance of each wind, reduced to the four cardinal points. The several radii drawn to the irregular boundary line show the number of days of duration in every year.

In Diagram 1, *that for the E. wind and its compounds.*—The average continuance of the E. wind is 56·6 days, therefore its average circle is but little removed from the 50 days' circle. By looking at the Diagram, it will be seen that the point in 1840 is a little outside the circle of average, but that it falls quite within in the years 1843 to 1848, showing a deficiency of E. wind, and, with the exception of one or two years, a general excess afterwards.

In Diagram 2, *that for N. wind and its compounds.*—The outer or average circle of the N. is further removed from the 50 days' circle than in Diagram 1; and here is shown a deficiency in 1841, increasing to a maximum in 1843 to 1845; a minimum in 1846, and an excess of N. wind from 1848 to 1853, the points projecting beyond the average in all these years; there was an excess in 1855 and 1856, and a general deficiency from 1857.

In Diagram 3, *that for the S. wind*, as found from itself and compounds, the average circle departs still more from the inner circle of 50 days' duration, the average being more than 96 days. There was an excess in 1841; a deficiency in the years 1842, 1843, and 1844; a general excess from 1845 to 1850; variable from 1851 to 1856, and but little departure from its average from 1857.

In Diagram 4, *that for the W. wind*, as found from itself and compounds, shows the largest exterior circle of any, corresponding to 102 days: in this Diagram the departure from the average was small from 1841 to 1845; but from 1846 to 1855, with the exception of 1854, there was a constant deficiency; and from the year

Diagrams showing the number of Days of continuance of each Wind, 1841 *to* 1860.

Diagram 1.

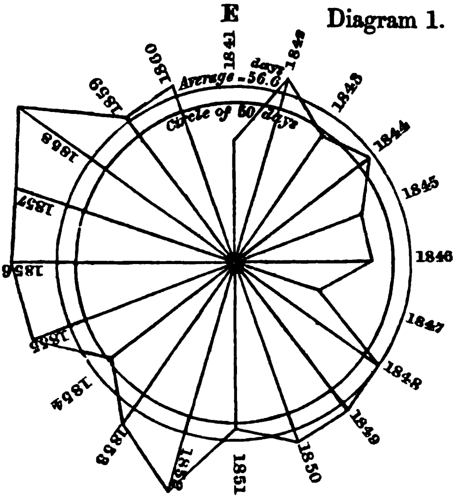
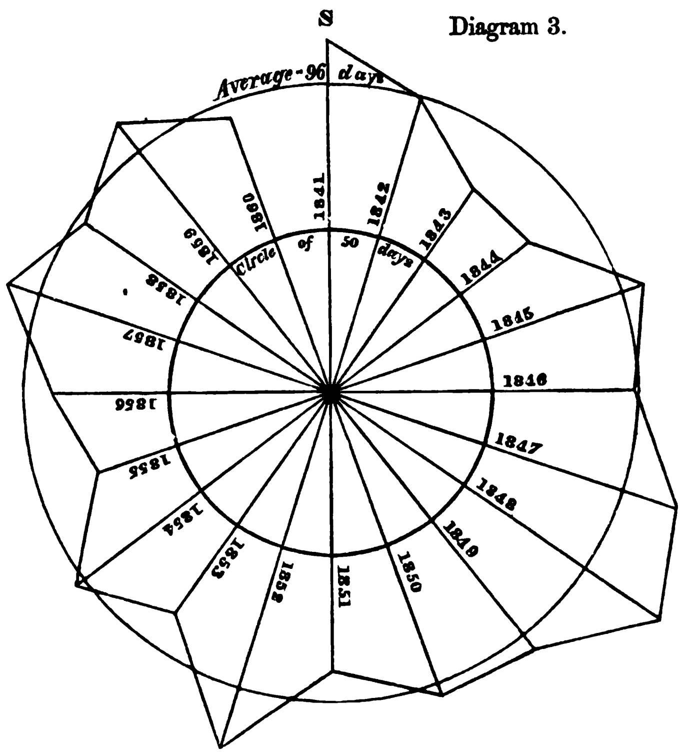
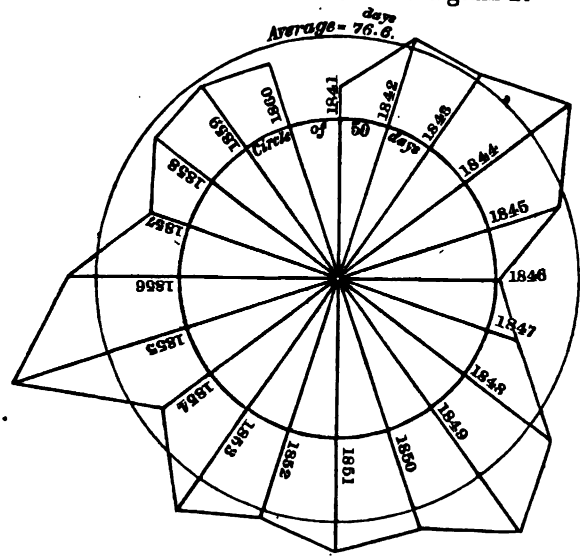


Diagram 3.

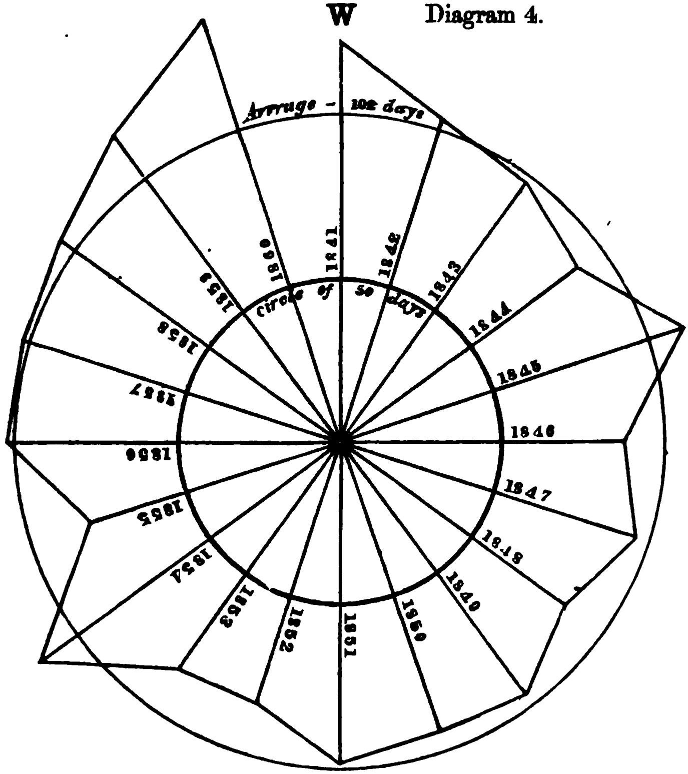


Scale 63 days to 1 inch.

N Diagram 2.



W Diagram 4.



Scale 63 days to 1 inch.

1855 there has been an increase year by year, each successive year showing an increase on the preceding, and above the average from 1856.

During all these years the excess or defect yearly of the whole number of revolutions of the vane of Osler's anemometer, of direct over retrograde, or of retrograde over direct, has been taken.

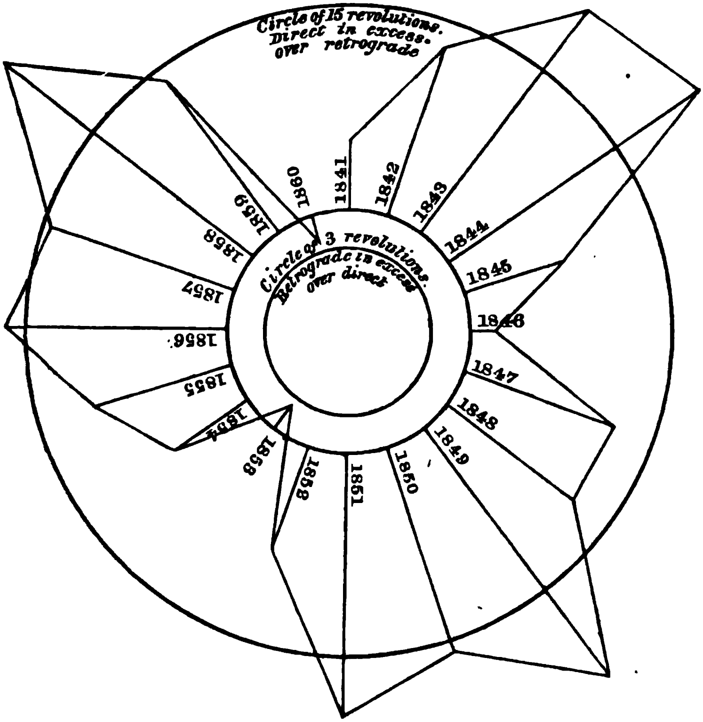
By direct motion is meant when the vane in its changing positions was moving in the order N., E., S., W., N. &c., or with the sun; by retrograde is meant in the order N., W., S., E., N., or backing against the sun.

In every year the whole angle through which the vane has turned in each direction has been determined, and the difference taken in terms of revolutions. In this way it was found—

In the year			
1841	the vane turned through an excess of		5·4 revolutions direct.
1842	"	"	13·1 revolutions direct.
1843	"	"	20·7 revolutions direct.
1844	"	"	21·7 revolutions direct.
1845	"	"	8·9 revolutions direct.
1846	"	"	1·8 revolutions direct.
1847	"	"	11·0 revolutions direct.
1848	"	"	12·1 revolutions direct.
1849	"	"	23·3 revolutions direct.
1850	"	"	15·9 revolutions direct.
1851	"	"	19·1 revolutions direct.
1852	"	"	8·8 revolutions direct.
1853	"	"	1·9 revolutions retrograde.
1854	"	"	6·8 revolutions direct.
1855	"	"	10·8 revolutions direct.
1856	"	"	16·1 revolutions direct.
1857	"	"	14·7 revolutions direct.
1858	"	"	24·1 revolutions direct.
1859	"	"	14·0 revolutions direct.
1860	"	"	2·1 revolutions retrograde.

Thus indicating a period of 7 years. These values have been laid down in Diagram 5, in which the innermost circle shows the years when the retrograde movement was greater than the direct, and the outermost when the direct exceeded the retrograde, the amounts being measured in both cases from the intermediate or neutral circle.

Diagram showing the annual excess of direct over retrograde, and vice versâ, *of the whole number of Revolutions of the Vane of Osler's Anemometer, from the year* 1841 *to* 1860. Diagram 5.



Scale 12 revolutions = 1 inch.

By comparing this figure with that for the N. wind, there seems to be some connexion between the excess above the average in the years 1843 and 1844, in both Diagrams, the deficiency in 1846, and the excess again in 1849; there is a want of agreement in 1853, and not a very close agreement afterwards; yet I cannot help feeling that some connexion exists between the curious law of periodic change in the amount of direct and retrograde motion of the vane, and the direction of wind.

Having determined the average number of days in each year of the duration of each wind, it is necessary to determine their distribution over the year; for this purpose I have collected from the second series of twenty Tables, all the results in each month together in all the years, and in this way the following twelve Tables, numbered IV. to XV., have been formed:—

TABLE IV. Showing the number of Days of Wind during the Month of January in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

JANUARY.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	5	3	2	1	5	5	7	2	1	7½	4	8	10½
1842.	6	2	0	3	2	11	1	3	3	8½	2½	9	8
1843.	2	1	0	0	1	10	9	1	7	3	½	6	14½
1844.	2	2	0	1	3	8	6	5	4	5½	1½	7½	12½
1845.	2	2	0	3	8	10	0	4	2	5	2½	14½	7
1846.	0	0	0	0	3	11	3	0	10	0	0	8½	8½
1847.	2	2	3	1	2	3	1	0	17	3	4½	4	2½
1848.	7	6	2	5	5	3	2	1	0	10½	7½	9	4
1849.	3	5	0	1	5	14	1	2	0	6½	3	12½	9
1850.	7	6	3	2	4	6	3	0	0	10	7	8	6
1851.	0	0	1	6	5	17	0	0	2	0	4	16½	8½
1852.	0	1	0	0	9	14	7	0	0	½	½	16	14
1853.	3	4	0	0	7	12	2	1	2	5½	2	13	8½
1854.	2	3	1	9	5	8	1	2	0	4½	7	13½	6
1855.	5	10	1	0	0	7	2	2	4	11	6	3½	6½
1856.	0	7	1	4	6	7	4	0	2	3½	6½	11½	7½
1857.	7	6	0	0	3	8	6	1	0	10½	3	7	10½
1858.	3	2	1	2	4	11	6	1	1	4½	3	10½	12
1859.	2	3	0	0	0	18	5	2	1	4½	1½	9	15
1860.	2	0	1	4	5	12	4	3	0	3½	3	13	11½

From this Table we see that in January, in the year 1846, no air whatever passed from either the N. or E., and but very little in the years 1847 and 1851; whilst in the years 1848, 1850, 1855, and 1857 the wind was blowing very continuously from those quarters. This month, in the year 1847, was remarkably calm.

TABLE V. Showing the number of Days of Wind during the Month of February in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

Years.	FEBRUARY.												
	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	1	6	7	1	6	2	1	2	2	5	10½	7½	3
1842.	1	0	3	1	4	14	1	1	3	1½	3½	11½	8½
1843.	6	8	6	1	0	2	1	3	1	11½	10½	1½	3½
1844.	4	0	1	0	3	10	3	3	5	5½	1	8	9½
1845.	4	3	1	0	5	3	2	5	5	8	2½	6½	6
1846.	0	0	0	1	3	8	4	4	8	2	½	7½	10
1847.	2	4	3	0	3	8	4	0	4	4	5	7	8
1848.	2	0	0	0	3	17	6	0	1	2	0	11½	14½
1849.	2	0	1	1	4	14	4	0	2	2	1½	11½	11
1850.	0	0	1	1	3	14	7	0	2	0	1½	10½	14
1851.	5	3	2	1	3	7	1	0	6	6½	4	7	4½
1852.	7	5	1	2	0	5	6	2	1	10½	4½	3½	9½
1853.	8	6	1	3	1	2	1	1	5	11½	5½	3½	2½
1854.	2	2	1	0	3	11	1	7	1	6½	2	8½	10
1855.	5	12	3	1	1	3	0	0	3	11	9½	3	1½
1856.	2	5	2	2	6	7	4	1	0	5	5½	10½	8
1857.	0	4	0	2	4	12	1	2	3	3	3	11	8
1858.	1	7	8	7	1	3	0	1	0	5	15	6	2
1859.	1	0	0	1	3	14	5	4	0	3	½	10½	14
1860.	6	7	1	0	3	4	5	3	0	11	4½	5	8½

In the year 1850 no air passed in this month from the N., and but little from the E.; in the years 1842, 1846, 1848, 1849, 1857, and 1859, the amount from either of those quarters was small; whilst in the years 1843, 1852, and 1853 it was very large. The calmest February was in 1846; in some instances, particularly towards the end of the series, there has been no calm day during the month.

TABLE VI. Showing the number of Days of Wind during the Month of March in each year, 1841 to 1860, referred to the eight points of Azimuthal Circle, and to the four Cardinal Points.

MARCH.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	0	0	1	1	7	12	7	2	1	1	1½	13½	14
1842.	4	0	0	1	3	14	6	3	0	5½	½	10½	14½
1843.	6	6	2	2	3	4	3	1	4	9½	6	6	5½
1844.	6	3	2	0	1	10	4	3	2	9	3½	6	10½
1845.	5	10	1	3	1	5	2	4	0	12	7½	4	7½
1846.	0	0	1	2	2	12	2	3	9	1½	2	9	9½
1847.	4	5	2	0	6	6	2	2	4	7½	4½	9	6
1848.	5	0	2	6	4	8	2	3	1	6½	5	11	7½
1849.	7	1	4	2	1	4	4	4	4	9½	5½	4	8
1850.	9	4	2	3	1	5	1	1	5	11½	5½	5	4
1851.	5	2	0	3	2	13	2	3	1	7½	2½	10	10
1852.	4	9	9	3	2	1	2	0	1	8½	15	4	2½
1853.	1	10	2	2	1	6	2	2	5	7	8	5	6
1854.	3	4	0	1	4	11	2	3	3	6½	2½	10	9
1855.	5	6	5	3	6	3	2	0	1	8	9½	9	3½
1856.	4	12	10	3	0	0	0	1	1	10½	17½	1½	½
1857.	1	2	4	6	3	7	2	4	2	4	8	9½	7½
1858.	1	4	3	1	1	6	6	5	4	5½	5½	4½	11½
1859.	2	0	0	0	2	15	6	6	0	5	0	9½	16½
1860.	2	3	0	0	1	11	8	6	0	6½	1½	6½	16½

This month, in the years 1841 and 1846, is distinguished by small volumes of air having passed from the N. or E.; in 1856 the wind blew for the whole month nearly from these quarters. The years 1845 and 1850 are also remarkable for long continuance of N. and E. winds. These cold winds are much more prevalent in this than in either of the two preceding months. This month, in the year 1846, was remarkably calm, and, as before observed, was almost free from cold winds.

TABLE VII. Showing the number of Days of Wind during the Month of April in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

APRIL.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	7	4	2	2	1	6	7	1	0	9½	5	5	10½
1842.	1	17	10	0	0	1	0	1	0	10	18½	½	1
1843.	2	4	3	0	0	12	2	3	4	4½	6	7	8½
1844.	4	4	2	2	2	12	2	1	1	6½	5	9	18½
1845.	4	7	1	1	4	7	0	3	3	9	5	8	5
1846.	5	4	4	2	3	7	3	2	0	8	7	7½	7½
1847.	4	1	0	1	6	10	2	5	1	8	1	11½	9½
1848.	8	6	1	3	4	3	2	3	0	12½	5½	7	5
1849.	6	4	1	2	4	6	5	2	0	9	4	8	9
1850.	5	5	1	3	4	8	1	0	3	7½	5	9½	5
1851.	6	5	4	3	2	8	2	0	0	8½	8	7½	6
1852.	1	10	12	1	1	4	0	0	1	6	17½	3½	2
1853.	3	4	2	1	1	4	6	6	3	8	4½	3½	11
1854.	4	7	8	1	0	3	4	3	0	9	12	2	7
1855.	7	9	2	2	1	2	5	1	1	12	7½	3	6½
1856.	1	6	2	6	6	6	0	2	1	5	8	12	4
1857.	1	5	2	3	4	8	2	4	1	5½	6	9½	8
1858.	4	7	7	3	1	4	3	1	0	8	12	4½	5½
1859.	4	2	2	3	3	11	1	4	0	7	4½	10	8½
1860.	3	10	3	2	1	3	4	4	0	10	9	3½	7½

The cold N. and E. winds have been more prevalent in this month than in March; they were least prevalent in the year 1847, and most in 1842. The air has been more generally in motion this month than in either January, February, or March, and in many instances not one day in the month has been classed as calm.

TABLE VIII. Showing the number of Days of Wind during the Month of May in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

MAY.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	2	4	4	1	6	12	1	1	0	4½	6½	12½	7½
1842.	3	5	0	2	5	11	2	2	1	6½	3½	11½	8½
1843.	3	6	4	1	0	10	2	0	5	6	7½	5½	7
1844.	10	14	3	2	0	1	0	1	0	17½	11	1½	1
1845.	8	6	1	0	2	3	4	3	4	12½	4	3½	7
1846.	2	4	2	3	3	7	5	1	4	4½	5½	8	9
1847.	1	0	2	1	12	10	1	0	4	1	2½	17½	6
1848.	3	5	8	4	1	4	1	0	5	5½	12½	5	3
1849.	8	5	0	2	5	6	1	2	2	11½	3½	9	5
1850.	5	8	2	2	1	7	2	1	3	9½	7	5½	6
1851.	7	3	1	2	3	4	1	5	5	11	3½	6	5½
1852.	7	9	1	0	3	9	2	0	0	11½	5½	7½	6½
1853.	1	13	4	4	0	2	2	2	3	8½	12½	3	4
1854.	2	5	0	0	4	17	1	0	2	4½	2½	12½	9½
1855.	8	7	2	3	1	6	0	3	1	13	7	5½	4½
1856.	10	3	0	2	4	9	1	2	0	12½	2½	9½	6½
1857.	1	13	5	1	1	8	2	0	0	8½	12	5½	6
1858.	4	5	1	0	1	14	5	1	0	7	3½	8	12½
1859.	1	23	4	2	1	0	0	0	0	12½	16½	2	0
1860.	0	2	5	2	1	11	7	2	1	2	7	7½	13½

During this month the N. and E. winds have been more prevalent than in any other month in the year; these amounts in a few years have been small, as in 1847 and 1860, whilst in other years, in 1844 and 1859, they have been almost continuous throughout the whole month; and from this series of twenty years, their average exceeds that of the S. and W.

TABLE IX. Showing the number of Days of Wind during the Month of June in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

JUNE.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	6	0	0	0	4	9	9	2	0	7	0	8½	14½
1842.	2	6	4	1	2	9	3	2	1	6	7½	7	8½
1843.	8	4	4	0	2	6	2	3	1	11½	6	5	6½
1844.	3	3	1	1	0	7	3	5	7	7	3	4	9
1845.	1	6	1	2	1	11	3	2	3	5	5	7½	9½
1846.	1	4	4	5	1	9	1	1	4	3½	8½	8	6
1847.	7	2	1	0	3	9	4	2	2	9	2	7½	9½
1848.	3	4	1	1	4	10	4	2	1	6	3½	9½	10
1849.	6	5	5	1	1	6	4	1	1	9	8	4½	7½
1850.	1	4	7	1	2	9	5	1	0	3½	9½	7	10
1851.	2	2	4	0	2	10	5	4	1	5	5	7	12
1852.	2	0	1	5	8	13	1	0	0	2	3½	17	7½
1853.	7	2	0	2	1	13	1	1	3	8½	2	8½	8
1854.	3	5	1	2	3	10	5	1	0	6	4½	9	10½
1855.	4	4	1	1	2	12	0	2	4	7	3½	8½	7
1856.	2	3	0	0	0	11	9	4	1	5½	1½	5½	16½
1857.	0	4	7	2	3	8	2	2	2	3	10	8	7
1858.	1	5	1	1	3	13	3	3	0	5	4	10	11
1859.	4	7	0	6	0	4	4	4	1	9½	6½	5	8
1860.	2	1	0	2	1	19	5	0	0	2½	1½	11½	14½

The frequency of the N. and E. winds this month is much less than in the preceding month; but there is no instance of a total absence of these winds; their amounts were small in 1850 and 1860, and large in 1843. The calmest June was in 1844; but there are several instances of air being in active movement on every day in the month.

TABLE X. Showing the number of Days of Wind during the Month of July in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

JULY.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	5	0	0	0	4	15	3	2	2	6	0	11½	11½
1842.	6	2	2	0	5	9	4	3	0	8½	3	9½	10
1843.	5	3	0	0	2	12	5	2	2	7½	1½	8	12
1844.	3	5	0	0	2	7	4	4	6	7½	2½	5½	9½
1845.	2	4	2	0	3	14	3	2	1	5	4	10	11
1846.	1	1	0	1	1	12	6	1	8	2	1	7½	12½
1847.	7	2	1	0	2	8	4	0	7	8	2	6	8
1848.	3	4	1	0	10	6	5	1	1	5½	3	13	8½
1849.	2	7	0	0	3	13	3	3	0	7	3½	9½	11
1850.	5	4	1	1	2	6	2	3	7	8½	3½	5½	6½
1851.	5	3	2	0	2	7	5	2	5	7½	3½	5½	9½
1852.	5	8	5	2	3	8	0	0	0	9	10	8	4
1853.	0	2	1	1	2	18	4	3	0	2½	2½	11½	14½
1854.	2	5	2	1	3	8	4	0	6	4½	5	7½	8
1855.	3	3	3	0	2	12	3	1	4	4½	5	9½	8
1856.	1	2	1	2	1	8	11	4	1	4	3	6	17
1857.	0	4	0	0	1	16	5	5	0	4½	2	9	15½
1858.	4	2	0	2	3	9	4	7	0	8½	2	8½	12
1859.	3	6	1	1	2	13	3	1	1	6½	4½	9	10
1860.	6	7	1	0	0	10	1	5	1	12	4½	5	8½

The frequency of the N. and E. winds is very nearly the same as in last month. The volume of air from these quarters was the least in 1846, and most in 1852. The wind blows both in this and in the last month about one day in three from these quarters. The calmest July was in 1846: in six instances out of the 20 years, there was not a single calm day in the month.

TABLE XI. Showing the number of Days of Wind during the Month of August in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

AUGUST.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	1	0	0	0	3	15	6	1	5	2	0	10½	13½
1842.	2	5	6	3	3	6	4	2	0	5½	10	7½	8
1843.	3	6	1	1	4	10	3	1	2	6½	4½	9½	8½
1844.	1	0	0	1	1	11	6	2	9	2	½	7	12½
1845.	2	2	1	0	3	12	7	4	0	5	2	9	15
1846.	6	5	0	1	4	6	0	2	7	9½	3	7½	4
1847.	5	1	2	0	2	11	3	0	7	5½	2½	7½	8½
1848.	1	2	0	2	6	10	3	0	7	2	2	12	8
1849.	5	3	0	3	3	9	5	3	0	8	3	9	11
1850.	3	2	1	0	2	12	1	2	8	5	2	8	8
1851.	3	7	1	0	2	9	5	2	2	7½	4½	6½	10½
1852.	6	1	0	2	8	12	0	2	0	7½	1½	15	7
1853.	5	5	3	1	3	9	2	0	3	7½	6	8	6½
1854.	3	2	0	1	0	14	2	3	6	5½	1½	7½	10½
1855.	2	0	0	2	2	10	5	4	6	4	1	8	12
1856.	3	3	3	4	3	8	5	0	2	4½	6½	9	9
1857.	2	7	2	2	1	10	3	1	3	6	6½	7	8½
1858.	3	6	3	2	3	7	3	4	0	8	7	7½	8½
1859.	2	3	0	1	4	11	5	4	1	5½	2	10	12½
1860.	1	0	0	0	2	17	9	2	0	2	0	10½	18½

The prevalence of N. and E. winds this month has decreased very much, and is as small as in January, which up to this time is the smallest in the year. The volume of air from these quarters was very small in the years 1841, 1844, 1848, 1855, and 1860; the largest amount passed in 1842. The calmest month was in 1844, but the years 1846, 1847, 1848, and 1850 were nearly as calm. In six instances there was no case of calm during the month.

TABLE XII. Showing the number of Days of Wind during the Month of September in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

SEPTEMBER.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	0	1	3	2	3	7	4	0	10	1	4	7½	7½
1842.	5	2	3	1	2	6	6	3	2	7½	4½	5½	10½
1843.	4	6	2	2	1	4	0	4	7	9	6	4	2
1844.	6	8	0	0	0	2	1	0	13	10	4	1	2
1845.	2	7	2	1	1	10	3	1	3	6	6	6½	8½
1846.	4	3	4	1	4	3	1	1	9	6	6	6	3
1847.	2	3	0	0	0	16	6	0	3	3½	1½	8	14
1848.	6	6	0	2	4	5	0	2	5	10	4	7½	3½
1849.	5	9	3	1	4	7	0	0	1	9½	8	8	3½
1850.	5	10	3	2	2	4	1	2	1	11	9	5	4
1851.	5	9	4	2	1	2	1	1	5	10	9½	3	2½
1852.	6	4	4	1	1	5	4	1	4	8½	6½	4	7
1853.	4	5	0	4	2	8	3	2	2	7½	4½	8	8
1854.	1	5	1	0	2	6	4	2	9	4½	3½	5	8
1855.	3	11	1	3	2	5	2	1	2	9	8	6	5
1856.	4	2	3	3	1	7	4	2	4	6	5½	6	8½
1857.	1	4	0	2	5	12	2	1	3	3½	3	12	8½
1858.	1	5	2	3	2	13	1	2	1	4½	6	10	8½
1859.	4	1	1	1	2	13	3	4	1	6½	2	9	11½
1860.	4	4	1	2	1	10	5	1	2	6½	4	7	10½

The prevalence of the N. and E. winds has increased considerably since the preceding month, and are as frequent as in March; in a few instances, as in 1841, 1847, and 1857, they have been of limited duration, but generally they have been of rather long continuance, and particularly so in 1850 and 1851. In 1844 this month was remarkably calm, and there is no instance during the series without a calm day having taken place in this month; and this is the only month to which such a remark applies.

TABLE XIII. Showing the number of Days of Wind during the Month of October in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

OCTOBER.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	7	1	0	1	3	9	5	1	4	8	1	8	10
1842.	10	0	0	0	1	5	5	3	7	11½	0	3½	9
1843.	3	0	0	1	2	10	6	4	5	5	½	7½	13
1844.	3	2	2	1	5	11	4	0	3	4	3½	11	9½
1845.	0	1	0	0	5	9	6	5	5	3	½	9½	13
1846.	2	0	0	2	4	7	3	1	12	2½	1	8½	7
1847.	4	1	2	0	6	10	3	0	5	4½	2½	11	8
1848.	6	2	0	5	10	5	0	3	0	8½	3½	15	4
1849.	4	7	0	3	3	10	3	0	1	7½	5	9½	8
1850.	5	2	0	0	1	15	2	5	1	8½	1	8½	12
1851.	1	1	1	1	4	13	6	2	2	2½	2	11	13½
1852.	4	5	0	2	4	10	3	3	0	8	3½	10	9½
1853.	1	4	1	2	6	8	3	0	6	3	4	11	7
1854.	1	4	3	2	2	5	5	3	6	4½	6	5½	9
1855.	4	2	1	0	2	9	5	7	1	8½	2	6½	13
1856.	2	6	4	4	1	4	3	0	7	5	9	5	5
1857.	3	1	2	5	3	9	4	0	4	3½	5	10	8½
1858.	1	7	4	1	1	10	5	2	0	5½	8	6½	11
1859.	1	2	3	4	3	9	4	1	4	2½	6	9½	9
1860.	0	2	0	2	2	14	10	1	0	1½	2	10	17½

The N. and E. winds this month are much less prevalent than in the preceding month, their frequency being of the same value as in January and August, in which months these winds are less frequent than at any other time of the year. In 1846, 1851, and 1860 but little wind blew from these quarters; there was a long continuance of N. wind in 1845. In 1846 the month was remarkably calm.

TABLE XIV. Showing the number of Days of Wind during the Month of November in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

NOVEMBER.

Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	5	0	3	0	4	11	2	1	4	5½	3	9½	8
1842.	5	1	3	2	1	9	2	2	5	6½	4½	6½	7½
1843.	0	0	0	0	2	12	1	4	11	2	0	8	9
1844.	3	5	1	2	4	10	2	2	1	6½	4½	10	8
1845.	0	1	1	3	7	7	5	0	6	½	3	12	8½
1846.	1	3	5	0	7	6	0	2	6	3½	6½	10	4
1847.	1	0	0	0	5	11	5	1	7	1½	0	10½	11½
1848.	7	0	0	4	1	12	3	3	0	8½	2	9	10½
1849.	3	6	2	4	4	7	2	2	0	7	7	9½	6½
1850.	2	3	0	2	2	17	1	3	0	5	3½	10½	11
1851.	10	2	0	0	1	3	5	5	4	13½	2	1½	9
1852.	2	6	2	1	9	8	1	0	1	5	5½	13½	5
1853.	4	2	1	4	4	4	3	3	5	6½	4	8	6½
1854.	7	3	0	3	3	11	1	2	0	9½	3	10	7½
1855.	7	8	0	2	4	3	2	2	2	12	5	6½	4½
1856.	9	2	1	0	1	2	3	9	3	14½	2	2	8½
1857.	5	8	6	3	2	2	0	0	4	9½	11½	4½	1
1858.	2	10	6	2	1	5	0	0	4	7	12	4½	2½
1859.	3	3	2	6	4	9	2	0	1	4½	6½	11½	6½
1860.	0	8	8	2	2	5	1	2	2	5	13	5½	4½

The N. and E. winds have again increased in frequency, and are but little less frequent than in March and September. At times these winds have been of short duration, as in 1843, 1845, and 1847; but in every year since 1847 they have been of longer duration than in those years. The N. wind was very prevalent in 1851, 1855, and 1856. In 1843 this month was very calm; in four cases in the 20 years there has not been one calm day in the month.

TABLE XV. Showing the number of Days of Wind during the Month of December in each year, 1841 to 1860, referred to the eight points of the Azimuthal Circle, and to the four Cardinal Points.

DECEMBER.													
Years.	Number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	1	0	0	0	3	9	8	2	8	2	0	7½	13½
1842.	1	0	0	1	3	17	4	0	5	1	½	12	12½
1843.	0	0	0	0	1	10	3	3	14	1½	0	6	9½
1844.	3	11	6	4	1	0	0	0	6	8½	13½	3	0
1845.	0	0	0	0	3	13	8	5	2	2½	0	9½	17
1846.	5	1	0	0	4	6	2	4	9	7½	½	7	7
1847.	2	2	0	1	8	9	1	0	8	3	1½	13	5½
1848.	2	3	4	4	6	7	1	2	2	4½	7½	11½	5½
1849.	8	2	4	3	2	6	3		0	10½	6½	6½	7½
1850.	2	0	3	4	6	13	1	1	1	2½	5	14½	8
1851.	3	2	1	2	1	7	4	1	10	4½	3	5½	8
1852.	1	0	1	2	4	19	1	0	3	1	2	14½	10½
1853.	6	8	1	3	0	0	3	6	4	13	6½	1½	6
1854.	1	0	0	0	1	13	12	4	0	3	0	7½	20½
1855.	3	2	4	0	2	12	4	3	1	5½	5	8	11½
1856.	6	3	0	0	2	11	6	1	2	8	1½	7½	12
1857.	0	0	0	1	3	19	5	1	2	½	½	13	15
1858.	1	1	2	3	5	11	4	2	2	2½	4	12	10½
1859.	4	4	3	4	1	11	2	1	1	6½	7	8½	8
1860.	4	3	6	3	3	4	5	2	1	6½	9	6½	8

The N. and E. winds have been of less frequent occurrence this month than in any month in the year. They have been frequently very small in amount, as in 1841, 1842, 1843, 1845, 1847, 1852, 1854, and 1857; occasionally they have been large, as in 1844, 1849, and 1853. In 1843 nearly one-half of the month was calm; and the month was calm in 1846 and 1851. In two instances only this month has passed without a calm day occurring.

By taking the means of the numbers in each of the twelve preceding Tables the next Table is formed, showing the average duration of each wind in every month.

TABLE XVI. Showing the average number of Days in each Month of each Wind, as found from all the Observations, 1841 to 1860, referred to eight points of the Azimuthal Circle, and reduced to the four Cardinal Points.

Month.	Average number of Days the Mean direction of the Wind was									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
January	3.00	3.25	0.80	2.10	4.10	9.75	3.50	1.50	2.80	5.4	3.5	10.0	9.1
February	2.95	3.60	2.10	1.25	2.95	8.00	2.85	1.95	2.60	5.7	4.6	7.6	7.8
March	3.70	4.05	2.50	2.10	2.55	7.65	3.25	2.80	2.40	7.1	5.6	7.4	8.5
April	4.00	6.05	3.45	2.05	2.40	6.25	2.55	2.30	0.95	8.2	7.6	6.6	6.8
May	4.30	7.00	2.45	1.70	2.70	7.55	2.00	1.30	2.00	8.5	6.8	7.3	6.4
June	3.25	3.55	2.15	1.65	2.15	9.90	3.65	2.10	1.60	6.1	4.7	7.9	9.6
July	3.40	3.70	1.15	0.55	2.65	10.55	3.95	2.45	2.60	6.4	3.3	8.3	10.4
August	2.95	3.00	1.15	1.30	2.95	10.45	3.85	1.95	3.40	5.4	3.3	8.8	10.0
September	3.60	5.25	1.85	1.65	2.00	7.25	2.55	1.50	4.35	7.0	5.3	6.4	6.8
October	3.10	2.50	1.15	1.80	3.40	9.10	4.25	2.05	3.65	5.4	3.3	8.8	9.8
November	3.80	3.55	2.05	2.00	3.40	7.70	2.05	2.15	3.30	6.7	4.9	8.2	7.0
December	2.65	2.10	1.75	1.75	2.95	9.85	3.85	2.05	4.05	4.7	3.7	8.7	9.8
Sums	40.70	47.60	22.55	19.90	34.20	104.00	38.30	24.10	33.70	76.6	56.6	96.0	102.0

This Table shows the average duration of each wind in every month; from it we learn that—

The N. wind is least prevalent in December.
The N. wind is most prevalent in May.

The N.E. wind is least prevalent in December.
The N.E. wind is most prevalent in May.

The E. wind is least prevalent in January.
The E. wind is most prevalent in April.

The S.E. wind is least prevalent in July.
The S.E. wind is most prevalent in March.

The S. wind is least prevalent in September and June.
The S. wind is most prevalent in January.

The S.W. wind is least prevalent in April.
The S.W. wind is most prevalent in July and August.

The W. wind is least prevalent in May and November.
The W. wind is most prevalent in October.

The N.W. wind is least prevalent in May.
The N.W. wind is most prevalent in March.

Calm days are least frequent in April.
Calm days are most frequent in September.

In every month the S.W. wind is a multiple of any other wind. In January, June, July, and August, this wind averages one-third of each of these months, and nearly one-third in October. In April its mean continuance is nearly one-fifth of the month, and in all the remaining months its duration is something more or less than one-fourth.

The absolute and relative duration of the other winds can be seen by inspection of the Table, and from thence how the yearly sums have been distributed over the year.

The sums of the numbers in every column, showing the average yearly continuance of each wind, are as follows:—

	Days.
N. wind, mean yearly continuance	40·70
N.E. wind, mean yearly continuance	47·60
E. wind, mean yearly continuance	22·55
S.E. wind, mean yearly continuance	19·90

	Days.
S. wind, mean yearly continuance	34·20
S.W. wind, mean yearly continuance	104·00
W. wind, mean yearly continuance	38·30
N.W. wind, mean yearly continuance	24·10
Calm wind, mean yearly continuance	33·70

These numbers are identical with those following Table II., and thus prove the correctness of the calculations up to this point. We can therefore use these numbers with confidence.

By taking the difference between the numbers in Table XVI., and the numbers for the different winds in every month in the several Tables IV. to XV., the next series of Tables are formed, showing the number of days of departure of each wind above or below its average, in every month.

TABLE XVII. Showing the number of Days of departure of each Wind during the Month of January in each of the years 1841 to 1860, from its average, referred to eight and to four points of the Compass.

JANUARY.													
Years.	Number of Days the Mean direction of the Wind differed from the average.									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	+2	0	+1	−1	+1	−5	+3	0	− 2	+2	+1	−2	+1½
1842.	+3	−1	−1	+1	−2	+1	−3	+1	0	+3	− ½	−1	−1
1843.	−1	−2	−1	−2	−3	0	+5	−1	+ 4	−2½	−2½	−4	+5½
1844.	−1	−1	−1	−1	+1	−2	+2	+3	+ 1	0	−1½	−2½	+3½
1845.	−1	−1	−1	+1	+4	0	−4	+2	− 1	− ½	− ½	+4½	−2
1846.	−3	−3	−1	−2	−1	+1	−1	−2	+ 7	−5½	−3	−1½	− ½
1847.	−1	−1	+2	−1	−2	−7	−3	−2	+14	−2½	+1	−6	−6½
1848.	+4	+3	+1	+3	+1	−7	−2	−1	− 3	+5	+4½	−1	−5
1849.	0	+2	−1	−1	+1	+4	−3	0	− 3	+1	0	+2½	0
1850.	+4	+3	+2	0	0	−4	+1	−2	− 3	+4½	+4	−2	−3
1851.	−3	−3	0	+4	+1	+7	−4	−2	− 1	−5½	+1	+6½	− ½
1852.	−3	−2	−1	−2	+5	+4	+3	−2	− 3	−5	−2½	+6	+5
1853.	0	+1	−1	−2	+3	+2	−2	−1	− 1	0	−1	+3	− ½
1854.	−1	0	0	+7	+1	−2	−3	0	− 3	−1	+4	+3½	−3
1855.	+2	+7	0	−2	−4	−3	−2	0	+ 1	+5½	+3	−6½	−2½
1856.	−3	+4	0	+2	+2	−3	0	−2	− 1	−2	+3½	+1½	−1½
1857.	+4	+3	−1	−2	−1	−2	+2	−1	− 3	+5	0	−3	+1½
1858.	0	−1	0	0	0	+1	+2	−1	− 2	−1	0	+ ½	+3
1859.	−1	0	−1	−2	−4	+8	+1	0	− 2	−1	−1½	−1	+6
1860.	−1	−3	0	+2	+1	+2	0	+1	− 3	−2	0	+3	+2½

The sign + denotes above and the sign − below the average, in this and the following Tables.

The same grouping of signs is shown here as in preceding Tables, indicating that groups of years occur together with less than the average, and other groups of years with more than the average duration of each wind; and this is indicated generally in every monthly Table.

In the preceding Table, it will be seen that at the beginning of the series the number of — signs are grouped together with the N., N.E., E., and S.E. winds; that in the middle of the Table, the same winds are grouped with + signs, showing they were above their averages in those years, and that towards the end of the series they are again below their averages.

TABLE XVIII. Showing the number of Days of departure of each Wind during the Month of February in each of the years 1841 to 1860, from its average, referred to eight and to four points of the Compass.

FEBRUARY.													
Years.	Number of Days the Mean direction of the Wind differed from the average.									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	−2	+2	+5	0	+3	−6	−2	0	−1	−1	+5½	− ½	−5
1842.	−2	−4	+1	0	+1	+6	−2	−1	0	−4½	−1½	+3½	+ ½
1843.	+3	+4	+4	0	−3	−6	−2	+1	−2	+5½	+5½	−6½	−4½
1844.	+1	−4	−1	−1	0	+2	0	+1	+2	− ½	−4	0	+1½
1845.	+1	−1	−1	−1	+2	−5	−1	+3	+2	+2	−2½	−1½	−2
1846.	−3	−4	−2	0	0	0	+1	+2	+5	−4	−4½	− ½	+2
1847.	−1	0	+1	−1	0	0	+1	−2	+1	−2	0	−1	0
1848.	−1	−4	−2	−1	0	+9	+3	−2	−2	−4	−5½	+3½	−6½
1849.	−1	−4	−1	0	+1	+6	+1	−2	−1	−4	−3½	+3½	+3
1850.	−3	−4	−1	0	0	+6	+4	−2	−1	−6	−3½	+2½	+6
1851.	+2	−1	0	0	0	−1	−2	−2	+3	+ ½	−1	−1	−3½
1852.	+4	+1	−1	+1	−3	−3	+3	0	−2	+4½	− ½	−4½	+1½
1853.	+5	+2	−1	+2	−2	−6	−2	−1	+2	+5½	+ ½	−4½	−5½
1854.	−1	−2	−1	−1	0	+3	−2	+5	−2	+ ½	−3	+ ½	+2
1855.	+2	+8	+1	0	−2	−5	−3	−2	0	+5	+4½	−5	−6½
1856.	−1	+1	0	+1	+3	−1	+1	−1	−3	−1	+ ½	+2½	0
1857.	−3	0	−2	+1	+1	+4	−2	0	0	−3	−2	+3	0
1858.	−2	+3	+6	+6	−2	−5	−3	−1	−3	−1	+10	−2	−6
1859.	−2	−4	−2	0	0	+6	+2	+2	−3	−3	−4½	+2½	+6
1860.	+3	+3	−1	−1	0	−4	+2	+1	−3	+5	− ½	−3	+ ½

TABLES XIX. and XX. Showing the number of Days of departure of each Wind during the Months of March and April in each of the years 1841 to 1860, from its average, referred to eight and to four points of the Compass.

Years.	Number of Days the Mean direction of the Wind differed from the average.									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
MARCH.													
1841.	-4	- 4	-2	-1	+4	+4	+4	-1	-1	-6	- 4½	+6½	+6
1842.	0	- 4	-3	-1	0	+6	+3	0	-2	-1½	- 5½	+3½	+6½
1843.	+2	+ 2	-1	0	0	-4	0	-2	+2	+2½	0	-1	-2½
1844.	+2	- 1	-1	-2	-2	+2	+1	0	0	+2	- 2½	-1	+2½
1845.	+1	+ 6	-2	+1	-2	-3	-1	+1	-2	+5	+ 1½	-3	- ½
1846.	-4	- 4	-2	0	-1	+4	-1	0	+7	-5½	- 4	+2	+1½
1847.	0	+ 1	-1	-2	+3	-2	-1	-1	+2	+ ½	- 1½	+2	-2
1848.	+1	- 4	-1	+4	+1	0	-1	0	-1	- ½	- 1	+4	- ½
1849.	+3	- 3	+1	0	-2	-4	+1	+1	+2	+2½	- ½	-3	0
1850.	+5	0	-1	+1	-2	-3	-2	-2	+3	+4½	- ½	-2	-4
1851.	+1	- 2	-3	+1	-1	+5	-1	0	-1	+ ½	- 3½	+3	+2
1852.	0	+ 5	+6	+1	-1	-7	-1	-3	-1	+1½	+ 9	-3	-5½
1853.	-3	+ 6	-1	0	-2	-2	-1	-1	+3	0	+ 2	-2	-2
1854.	-1	0	-3	-1	+1	+3	-1	0	+1	- ½	- 3½	+3	+1
1855.	+1	+ 2	+2	+1	+3	-5	-1	-3	-1	+1	+ 3½	+2	-4½
1856.	0	+ 8	+7	+1	-3	-8	-3	-2	-1	+3½	+11½	-5½	-7½
1857.	-3	- 2	+1	+4	0	-1	-1	+1	0	-3	+ 2	+2½	- ½
1858.	-3	0	0	-1	-2	-2	+3	+2	+2	-1½	- ½	-2½	+3½
1859.	-2	- 4	-3	-2	-1	+7	+3	+3	-2	-2	- 6	+2½	+8½
1860.	-2	- 1	-3	-2	-2	+3	+5	+3	-2	- ½	- 4½	- ½	+8½
APRIL.													
1841.	+3	- 2	-1	0	-1	0	+4	-1	-1	+1½	- 3	-2	+3½
1842.	-3	+11	+7	-2	-2	-5	-3	-1	-1	+2	+10½	-6½	-6
1843.	-2	- 2	0	-2	-2	+6	-1	+1	+3	-3½	- 2	0	+1½
1844.	0	- 2	-1	0	0	+6	-1	-1	0	-1½	- 3	+2	+1½
1845.	0	+ 1	-2	-1	+2	+1	-3	+1	+2	+1	- 3	+1	-2
1846.	+1	- 2	+1	0	+1	+1	0	0	-1	0	- 1	+ ½	+ ½
1847.	0	- 5	-3	-1	+4	+4	-1	+3	0	0	- 7	+4½	+2½
1848.	+4	0	-2	+1	+2	-3	-1	+1	-1	+4½	- 2½	0	-2
1849.	+2	- 2	-2	0	+2	0	+2	0	-1	+1	- 4	+1	+2
1850.	+1	- 1	-2	+1	+2	+2	-2	-2	+2	- ½	- 3	+2½	-2
1851.	+2	- 1	+1	+1	0	+2	-1	-2	-1	+ ½	0	+ ½	-1
1852.	-3	+ 4	+9	-1	-1	-2	-3	-2	0	-2	+ 9½	-3½	-5
1853.	-1	- 2	-1	-1	-1	-2	+3	+4	+2	0	- 3½	-3½	+4
1854.	0	+ 1	+5	-1	-2	-3	+1	+1	-1	+1	+ 4	-5	0
1855.	+3	+ 3	-1	0	-1	-4	+2	-1	0	+4	- ½	-4	- ½
1856.	-3	0	-1	+4	+4	0	-3	0	0	-3	0	+5	-3
1857.	-3	- 1	-1	+1	+2	+2	-1	+2	0	-2½	- 2	+2½	+1
1858.	0	+ 1	+4	+1	-1	-2	0	-1	-1	0	+ 4	-2½	-1½
1859.	0	- 4	-1	+1	+1	+5	-2	+2	-1	-1	- 3½	+3	+1½
1860.	-1	+ 4	0	0	-1	-3	+1	+2	-1	+2	+ 1	-3½	+ ½

Tables XXI and XXII. Showing the number of Days of departure of each Wind during the Months of May and June in each of the years 1841 to 1860, from its average, referred to eight and to four points of the Compass.

MAY.

Years.	Number of Days the Mean direction of the Wind differed from the average.									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	−2	− 3	+2	−1	+3	+4	−1	0	−2	−4½	− ½	+ 5½	+1½
1842.	−1	− 2	−2	0	+2	+3	0	+1	−1	−2½	−3½	+ 4½	+2½
1843.	−1	− 1	+2	−1	−3	+2	0	−1	+3	−3	+ ½	− 1½	+1
1844.	+6	+ 7	+1	0	−3	−7	−2	0	−2	+8½	+4	− 5½	−5
1845.	+4	− 1	−1	−2	−1	−5	+2	+2	+2	+3½	−3	− 3½	+1
1846.	−2	− 3	0	+1	0	−1	+3	0	+2	−4½	−1½	+ 1	+3
1847.	−3	− 7	0	−1	+9	+2	−1	−1	+2	−8	−4½	+10½	0
1848.	−1	− 2	+6	+2	−2	−4	−1	−1	+3	−3½	+5½	− 2	−3
1849.	+4	− 2	−2	0	+2	−2	−1	+1	0	+2½	−3½	+ 2	−1
1850.	+1	+ 1	0	0	−2	−1	0	0	+1	+ ½	0	− 1½	0
1851.	+3	− 4	−1	0	0	−4	−1	+4	+3	+2	−3½	− 1	− ½
1852.	+3	+ 2	−1	−2	0	+1	0	−1	−2	+2½	−1½	+ ½	+ ½
1853.	−3	+ 6	+2	+2	−3	−6	0	+1	+1	− ½	+5½	− 4	−2
1854.	−2	− 2	−2	−2	+1	+9	−1	−1	0	−4½	−4½	+ 5½	+3½
1855.	+4	0	0	+1	−2	−2	−2	+2	−1	+4	0	− 1½	−1½
1856.	+6	− 4	−2	0	+1	+1	−1	+1	−2	+3½	−4½	+ 2½	+ ½
1857.	−3	+ 6	+3	−1	−2	0	0	−1	−2	− ½	+5	− 1½	0
1858.	0	− 2	−1	−2	−2	+6	+3	0	−2	−2	−3½	+ 1	+6½
1859.	−3	+16	+2	0	−2	−8	−2	−1	−2	+3½	+9½	− 5	−6
1860.	−4	− 5	+3	0	−2	+3	+5	+1	−1	−7	0	+ ½	+7½

JUNE.

Years.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	+3	− 4	−2	−2	+2	−1	+5	0	−2	+1	−5	+ ½	+4½
1842.	−1	+ 2	+2	−1	0	−1	−1	0	−1	0	+2½	− 1	−1½
1843.	+5	0	+2	−2	0	−4	−2	+1	−1	+5½	+1	− 3	−3½
1844.	0	− 1	−1	−1	−2	−3	−1	+3	+5	+1	−2	− 4	−1
1845.	−2	+ 2	−1	0	−1	+1	−1	0	+1	−1	0	− ½	− ½
1846.	−2	0	+2	+3	−1	−1	−3	−1	+2	−2½	+3½	0	−4
1847.	+4	− 2	−1	−2	+1	−1	0	0	0	+3	−3	− ½	− ½
1848.	0	0	−1	−1	+2	0	0	0	−1	0	−1½	+ 1½	0
1849.	+3	+ 1	+3	−1	−1	−4	0	−1	−1	+3	+3	− 3½	−2½
1850.	−2	0	+5	−1	0	−1	+1	−1	−2	−2½	+4½	− 1	0
1851.	−1	− 2	+2	−2	0	0	+1	+2	−1	−1	0	− 1	+2
1852.	−1	− 4	−1	+3	+6	+3	−3	−2	−2	−4	−1½	+ 9	−2½
1853.	+4	− 2	−2	0	−1	+3	−3	−1	+1	+2½	−3	+ ½	−2
1854.	0	+ 1	−1	0	+1	0	+1	−1	−2	0	− ½	+ 1	+ ½
1855.	+1	0	−1	−1	0	+2	−4	0	+2	+1	−1½	+ ½	−3
1856.	−1	− 1	−2	−2	−2	+1	+5	+2	−1	− ½	−3½	− 2½	+6½
1857.	−3	0	+5	0	+1	−2	−2	0	0	−3	+5	0	−3
1858.	−2	+ 1	−1	−1	+1	+3	−1	+1	−2	−1	−1	+ 2	+1
1859.	+1	+ 3	−2	+4	−2	−6	0	+2	−1	+3½	+1½	− 3	−2
1860.	−1	− 3	−2	0	−1	+9	+1	−2	−2	−3½	−3½	+ 3½	+4½

TABLES XXIII and XXIV. Showing the number of Days of departure of each Wind during the Months of July and August in each of the years 1841 to 1860, from its average, referred to eight and to four points of the Compass.

Years.	Number of Days the Mean direction of the Wind differed from the average.									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
							JULY.						
1841.	+2	−4	−1	−1	+1	+4	−1	0	−1	−0	−3	+3½	+1½
1842.	+3	−2	+1	−1	+2	−2	0	+1	−3	+2½	0	+1½	0
1843.	+2	−1	−1	−1	−1	+1	+1	0	−1	+1½	−1½	0	+2
1844.	0	+1	−1	−1	−1	−4	0	+2	+3	+1½	− ½	−2½	− ½
1845.	−1	0	+1	−1	0	+3	−1	0	−2	−1	+1	+2	+1
1846.	−2	−3	−1	0	−2	+1	+2	−1	+5	−4	−2	− ½	+2½
1847.	+4	−2	0	−1	−1	−3	0	−2	+4	+2	−1	−2	−2
1848.	0	0	0	−1	+7	−5	+1	−1	−2	− ½	0	+5	−1½
1849.	−1	+3	−1	−1	0	+2	−1	+1	−3	+1	+ ½	+1½	+1
1850.	+2	0	0	0	−1	−5	−2	+1	+4	+2½	+ ½	−2½	−3½
1851.	+2	−1	+1	−1	−1	−4	+1	0	+2	+1½	+ ½	−2½	− ½
1852.	+2	+4	+4	+1	0	−3	−4	−2	−3	+3	+7	0	−6
1853.	−3	−2	0	0	−1	+7	0	+1	−3	−3½	− ½	+3½	+4½
1854.	−1	+1	+1	0	0	−3	0	−2	+3	−1½	+2	− ½	−2
1855.	0	−1	+2	−1	−1	+1	−1	−1	+1	−1½	+2	+1½	−2
1856.	−2	−2	0	+1	−2	−3	+7	+2	−2	−2	0	−2	+7
1857.	−3	0	−1	−1	−2	+5	+1	+3	−3	−1½	−1	+1	+5½
1858.	+1	−2	−1	+1	0	−2	0	+5	−3	+2½	−1	+ ½	+2
1859.	0	+2	0	0	−1	+2	−1	−1	−2	+ ½	+1½	+1	0
1860.	+3	+3	0	−1	−3	−1	−3	+3	−2	+6	+1½	−3	−1½
							AUGUST.						
1841.	−2	−3	−1	−1	0	+5	+2	−1	+2	−3	−3	+1½	+3½
1842.	−1	+2	+5	+2	0	−4	0	0	−3	+ ½	+7	−1½	−2
1843.	0	+3	0	0	+1	0	−1	−1	−1	+1½	+1½	+ ½	−1½
1844.	−2	−3	−1	0	−2	+1	+2	0	+6	−3	−2½	−2	+2½
1845.	−1	−1	0	−1	0	+2	+3	+2	−3	0	−1	0	+5
1846.	+3	+2	−1	0	+1	−4	−4	0	+4	+4½	0	−1½	−6
1847.	+2	−2	+1	−1	−1	+1	−1	−2	+4	+ ½	− ½	−1½	−1½
1848.	−2	−1	−1	+1	+3	0	−1	−2	+4	−3	−1	+3	−2
1849.	+2	0	−1	+2	0	−1	+1	+1	−3	+3	0	0	+1
1850.	0	−1	0	−1	−1	+2	−3	0	+5	0	−1	−1	−2
1851.	0	+4	0	−1	−1	−1	+1	0	−1	+2½	+1½	−2½	+ ½
1852.	+3	−2	−1	+1	+5	+2	−4	0	−3	+2½	−1½	+6	−3
1853.	+2	+2	+2	0	0	−1	−2	−2	0	+2½	+3	−1	−3½
1854.	0	−1	−1	0	−3	+4	−2	+1	+3	+ ½	−1½	−1½	+ ½
1855.	−1	−3	−1	+1	−1	0	+1	+2	+3	−1	−2	−1	+2
1856.	0	0	+2	+3	0	−2	+1	−2	−1	− ½	+3½	0	−1
1857.	−1	+4	+1	+1	−2	0	−1	−1	0	+1	+3½	−2	−1½
1858.	0	+3	+2	+1	0	−3	−1	+2	−3	+3	+4	−1½	−1½
1859.	−1	0	−1	0	+1	+1	+1	+2	−2	+ ½	−1	+1	+2½
1860.	−2	−3	−1	−1	−1	+7	+5	0	−3	−3	−3	+1½	+8½

TABLES XXV. and XXVI. Showing the number of Days of departure of each Wind during the Months of September and October in each of the years 1841 to 1860, from its average, referred to eight and to four points of the Compass.

SEPTEMBER.

Years.	Number of Days the Mean direction of the Wind differed from the average.									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	−4	−4	+1	0	+1	0	+1	−2	+6	−6	−1	+1½	+½
1842.	+1	−3	+1	−1	0	−1	+3	+1	−2	+½	−½	−½	+3½
1843.	0	+1	0	0	−1	−3	−3	+2	+3	+2	+1	−2	−5
1844.	+2	+3	−2	−2	−2	−5	−2	−2	+9	+3	−1	−5	−5
1845.	−2	+2	0	−1	−1	+3	0	−1	−1	−1	+1	+½	+1½
1846.	0	−2	+2	−1	+2	−4	−2	−1	+5	−1	+1	0	−4
1847.	−2	−2	−2	−2	−2	+9	+3	−2	−1	−3½	−3½	+2	+7
1848.	+2	+1	−2	0	+2	−2	−3	0	+1	+3	−1	+1½	−3½
1849.	+1	+4	+1	−1	+2	0	−3	−2	−3	+2½	+3	+2	−3½
1850.	+1	+5	+1	0	0	−3	−2	0	−3	+4	+4	−1	−3
1851.	+1	+4	+2	0	−1	−5	−2	−1	+1	+3	+4½	−3	−4½
1852.	+2	−1	+2	−1	−1	−2	+1	−1	0	+1½	+1½	−2	0
1853.	0	0	−2	+2	0	+1	0	0	−2	+½	−½	+2	+1
1854.	−3	0	−1	−2	0	−1	+1	0	+5	−2½	−1½	−1	+1
1855.	−1	+6	−1	+1	0	−2	−1	−1	−2	+2	+3	0	−2
1856.	0	−3	+1	+1	−1	0	+1	0	0	−1	+½	0	+1½
1857.	−3	−1	−2	0	+3	+5	−1	−1	−1	−3½	−2	+6	+1½
1858.	−3	0	0	+1	0	+6	−2	0	−3	−2½	+1	+4	+1½
1859.	0	−4	−1	−1	0	+6	0	+2	−3	−½	−3	+3	+4½
1860.	0	−1	−1	0	−1	+3	+2	−1	−2	−½	−1	+1	+3½

OCTOBER.

Years.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	+4	−2	−1	−1	0	0	+1	−1	0	+3	−2	−1	0
1842.	+7	−3	−1	−2	−2	−4	+1	+1	+3	+6½	−3	−5½	−1
1843.	0	−3	−1	−1	−1	+1	+2	+2	+1	0	−2½	−1½	+3
1844.	0	−1	+1	−1	+2	+2	0	−2	−1	−1	+½	+2	−½
1845.	−3	−2	−1	−2	+2	0	+2	+3	+1	−2	−2½	+½	+3
1846.	−1	−3	−1	0	+1	−2	−1	−1	+8	−2½	−2	−½	−3
1847.	+1	−2	+1	−2	+3	+1	−1	−2	+1	−½	−½	+2	−2
1848.	+3	−1	−1	+3	+7	−4	−4	+1	−4	+3½	+½	+6	+6
1849.	+1	+4	−1	+1	0	+1	−1	−2	−3	+2½	+2	+½	−2
1850.	+2	−1	−1	−2	−2	+6	−2	+3	−3	+3½	−2	−½	+2
1851.	−2	−2	0	−1	+1	+4	+2	0	−2	−2½	−1	+2	+3½
1852.	+1	+2	−1	0	+1	+1	−1	+1	−4	+3	+½	+1	−½
1853.	−2	+1	0	0	+3	−1	−1	−2	+2	−2	+1	+2	−3
1854.	−2	+1	+2	0	−1	−4	+1	+1	+2	−½	+3	−3½	−1
1855.	+1	−1	0	−2	−1	0	+1	+5	−3	+3½	−1	−2½	+3
1856.	−1	+3	+3	+2	−2	−5	−1	−2	+3	0	+6	−4	−5
1857.	0	−2	+1	+3	0	0	0	−2	0	−1½	+2	+1	−1½
1858.	−2	+4	+3	−1	−2	+1	+1	0	−4	+½	+5	−2½	+1
1859.	−2	−1	+2	+2	0	0	0	−1	0	−2½	+3	+½	−1
1860.	−3	−1	−1	0	−1	+5	+6	−1	−4	−3½	−1	+1	+7½

TABLES XXVII. and XXVIII. Showing the number of Days of departure of each Wind during the Months of November and December in each of the years 1841 to 1860, from its average, referred to eight and to four points of the Compass.

NOVEMBER.

Years.	Number of Days the Mean direction of the Wind differed from the average.									Resolved Number to Cardinal Points.			
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	+1	−4	+1	−2	+1	+3	0	−1	+1	−1½	+2	+1½	+ 1
1842.	+1	−3	+1	0	−2	+1	0	0	+2	− ½	− ½	−1½	+ ½
1843.	−4	−4	−2	−2	−1	+4	−1	+2	+8	−5	−5	0	+ 2
1844.	−1	+1	−1	0	+1	+2	0	0	−2	− ½	− ½	+2	+ 1
1845.	−4	−3	−1	+1	+4	−1	+3	−2	+3	−6½	−2	+4	+ 1½
1846.	−3	−1	+3	−2	+4	−2	−2	0	+3	−3½	+1½	+2	− 3
1847.	−3	−4	−2	−2	+2	+3	+3	−1	+4	−5½	−5	+2½	+ 4½
1848.	+3	−4	−2	+2	−2	+4	+1	+1	−3	+1½	−3	+1	+ 3½
1849.	−1	+2	0	+2	+1	−1	0	0	−3	0	+2	+1½	− ½
1850.	−2	−1	−2	0	−1	+9	−1	+1	−3	−2	−1½	+2½	+ 4
1851.	+6	−2	−2	−2	−2	−5	+3	+3	+1	+6½	−3	−6½	+ 2
1852.	−2	+2	0	−1	+6	0	−1	−2	−2	−2	+ ½	+5½	− 2
1853.	0	−2	−1	+2	+1	−4	+1	+1	+2	− ½	−1	0	− ½
1854.	+3	−1	−2	+1	0	+3	−1	0	−3	+2½	−2	+2	+ ½
1855.	+3	+4	−2	0	+1	−5	0	0	−1	+5	0	−1½	− 2½
1856.	+5	−2	−1	−2	−2	−6	+1	+7	0	+7½	−3	−6	+ 1½
1857.	+1	+4	+4	+1	−1	−6	−2	−2	+1	+2½	+6½	−3½	− 6
1858.	+2	+6	+4	0	−2	−3	−2	−2	+1	0	+7	−3½	− 4½
1859.	−1	−1	0	+4	+1	+1	0	−2	−2	−2½	+1½	+3½	− ½
1860.	−4	+4	+6	0	−1	−3	−1	0	−1	−2	+8	−2½	− 2½

DECEMBER.

Years.	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	N.	E.	S.	W.
1841.	−2	−2	−2	−2	0	− 1	+4	0	+ 4	−3	−4	−1½	+ 3½
1842.	−2	−2	−2	−1	0	+ 7	0	−2	+ 1	−4	−3½	+3	+ 2½
1843.	−3	−2	−2	−2	−2	0	−1	+1	+10	−3½	−4	−3	− ½
1844.	0	+9	+4	+2	−2	−10	−4	−2	+ 2	+3½	+9½	−6	−10
1845.	−3	−2	−2	−2	0	+ 3	+4	+3	− 2	−2½	−4	+ ½	+ 7
1846.	+2	−1	−2	−2	+1	− 4	−2	+2	+ 5	+2½	−3½	− 2	− 3
1847.	−1	0	−2	−1	+5	− 1	−3	−2	+ 4	−2	−2½	+4	− 4½
1848.	−1	+1	+2	+2	+3	− 3	−3	0	− 2	− ½	+3½	+1½	− 4½
1849.	+5	0	+2	+1	−1	− 4	−1	+1	− 4	+5½	+2½	−2½	− 2½
1850.	−1	−2	+1	+2	+3	+ 3	−3	−1	− 3	−2½	+1	+5½	− 2
1851.	0	0	−1	0	−2	− 3	0	−1	+ 6	− ½	−1	−3½	− 2
1852.	−2	−2	−1	0	+1	+ 9	−3	−2	− 1	−4	−2	+5½	+ ½
1853.	+3	+6	−1	+1	−3	−10	−1	+4	0	+8	+2½	−7½	− 4
1854.	−2	−2	−2	−2	−2	+ 3	+8	+2	− 4	−2	−4	−1½	+10½
1855.	0	0	+2	−2	−1	+ 2	0	+1	− 3	+ ½	+1	−1	+ 1½
1856.	+3	+1	−2	−2	−1	+ 1	+2	−1	− 2	+3	−2½	−1½	+ 2
1857.	−3	−2	−2	−1	0	+ 9	+1	−1	− 2	−4½	−3½	+4	+ 5
1858.	−2	−1	0	+1	+2	+ 1	0	0	− 2	−2½	0	+3	+ ½
1859.	+1	+2	+1	+2	−2	+ 1	−2	−1	− 3	+1½	+3	− ½	− 2
1860.	+1	+1	+4	+1	0	− 6	+1	0	− 3	+1½	+5	−2½	− 2

By reducing the numbers in the first part of Table XVI. to the four cardinal points, the second part of the same Table is formed; and taking the sums, we find that each wind, as found from itself and compounds, is as follows:—

The average duration of N. is 76·6 days;
The average duration of E. is 56·6 days;
The average duration of S. is 96·0 days;
The average duration of W. is 102·0 days;

being identical with those found from the numbers in the second part of Table II., and thus certifying their correctness in both cases.

By consulting the numbers in the last columns of Table XVI. in every month, with those in the last columns of Tables IV. to XV., the mean duration of each wind, with its extreme durations, are readily found as follows:—

North and its compounds, reduced to North.

In *January* the average duration from the 20 years is 5½ days nearly; in 1855 they continued 11 days; in the years 1846 and 1851 scarcely any air passed from these quarters.

In *February* the average duration is 5¾ days; in 1843 and 1853 they continued 11½ days; in 1850 no air passed from these directions.

In *March* the average number of days is 7; in the year 1845 they amounted to 12; in 1841 to 1 only, deduced from 2 days prevalent N.W. wind.

In *April* the average is 8¼ days; it was 12½ days in 1848, and never less than 5 days, which occurred in 1852.

In *May* the average number is 8½ days; it was prevalent 17½ days in 1844, and on 1 day only in 1847.

In *June* the average is 6 days; in the year 1843 it was 11½ days; and in 1852 it blew on 2 days only from this direction.

In *July* the average number of days is 6½; in 1860 it blew on 12 days, and in 1846 on 2 days only.

In *August* the average is 5½ days; in 1846 it blew on 9½ days, and in 1841, 1844, 1848, and 1860 it blew on 2 days only.

In *September* the average is 7 days; in 1850 it was prevalent on 11 days, and in 1841 on 1 day only.

In *October* the average is 5½ days; in 1842 it blew on 11½ days, and in 1860 on 1½ day only.

In *November* the average duration is 6¾ days; on 14½ days it prevailed in 1846, and blew on 1 day only in 1845.

In *December* the average duration is 4¾ days; it was prevalent on 10½ days in 1849, and on 1 day only in 1857.

East and its compounds, reduced to East.

In *January* the average duration of the E. wind from the 20 years is 3½ days; in 1848 it was prevalent on 7½ days, and on 1 day only in 1843 and 1852.

In *February* the average number is 4½ days; it blew on 15 days in 1858, and in 1848 and 1849 no air passed from this quarter.

In *March* the average is 5½ days; it blew on 17½ days in 1856, and in 1842 and 1859 no air passed from these directions.

In *April* the average is 7½ days; it was prevalent, however, in 1842 on 18½ days, in 1847 on 1 day only.

In *May* the average is 6¾ days; in 1859 it blew on 16½ days, and on 2½ days only in three instances, 1847, 1854, and 1856.

In *June* the average duration is 4¾ days; in 1857 it blew on 10 days, and in 1841 it did not blow on any one day from this direction.

In *July* the average duration is 3¼ days; in 1852 it was prevalent on 10 days; in 1841 it did not pass once from this direction.

In *August* the average is 3¼ days; in 1842 it blew on 10 days, and in 1841 no air passed from this quarter.

In *September* the average is 5¼ days; in the year 1851 it was prevalent on 9½ days, and in 1847 on 1½ day only.

In *October* the average duration is 3¼ days; in 1856 it was 9 days, and in 1842 no air passed from this quarter.

In *November* the average is 5 days; it blew on 13 days in the year 1860; no air passed from this direction in the years 1843 and 1847.

In *December* the average is 3¾ days; in the year 1844 it blew on 13½ days; in 1841, 1845, and 1854 it did not blow once from this direction.

South and its compounds, reduced to South.

In *January* the average duration of the S. wind from the 20 years is 10 days; in the year 1851 it was 16½ days, and in 1855 it blew on 3½ days only.

In *February* the average duration is 7½ days; in 1842, 1848, and 1849 it was prevalent on 11½ days, and in 1843 on 1½ day only.

In *March* the average is 7½ days; in 1841 it was prevalent on 13½ days, and in 1856 on 1½ day only.

In *April* the average is 6½ days; in the year 1856 it blew on 12 days, and in 1842 on ½ day only.

In *May* the average is 7¼ days; in the year 1847 it blew on 17½ days, and in 1844 on 1½ day only.

In *June* the average is 8 days nearly; in 1852 it blew on 17 days; in 1844 it blew on 4 days only.

In *July* the average duration is 8¼ days; in the year 1848 it blew on 13 days, and in 1860 on 5 days only.

In *August* the average is 8¾ days; in 1852 it was prevalent on 15 days, and in 1851 on 6½ days only.

In *September* the average is 6½ days; in the year 1857 it blew on 12 days, and in 1844 on 1 day only.

In *October* the average is 8¾ days; in the year 1848 it blew on 15 days, and in 1842 on 3½ days only.

In *November* the average duration is 8¼ days; in the year 1852 it was 13½ days, and in 1856 it was 2 days only.

In *December* the average is 8¾ days; the greatest number was 14½ days in 1852, and the least 1½ day in 1853.

West and its compounds, reduced to West.

In *January* the average duration of the W. wind from the twenty years is 9 days; in 1859 it blew on 15 days from this direction, and in 1847 on 2½ days only.

In *February* the average duration is 7¾ days; in 1848 it blew on 15 days, and in 1841 and 1858 on 2 days only.

In *March* the *average* is 8½ days; the greatest number was 16½ days in 1859 and 1860, and the least 1 day in 1856.

In *April* the average duration is 6¾ days; in 1853 it blew on 11 days, and in 1842 on 1 day only.

In *May* the average is 6½ days; in 1860 it blew on 13½ days, and in 1859 no air passed from this quarter.

In *June* the average is 9½ days; in 1856 it blew on 16½ days, and in 1846 on 6 days only.

In *July* the average duration is 10½ days; the greatest number was 17 days in 1856, and the least 4 days in 1852.

In *August* the average is 10 days; in 1860 it was prevalent on 18½ days, and in 1846 on 4 days only.

In *September* the average is 7 days; in 1847 it blew on 14 days, and in 1843 and 1844 on 2 days only.

In *October* the average is 9¾ days; in 1860 it blew on 17½ days, and in 1848 on 4 days only.

In *November* the average is 7 days; in 1847 it was prevalent on 11½ days, and in 1857 on 1 day only.

In *December* the average is 9¾ days; in 1854 it was prevalent on 20½ days, and in 1844 no air passed from this quarter.

Important as the Anemometrical Observations at the Royal Observatory at Greenwich are, yet they exhibit the results but for one spot on the earth, and would be greatly increased in value if they could be combined with results deduced from other places.

I feel certain that, in determining the laws of periodical atmospheric currents, we must call in aid more instrumental means; and that some of the instruments must be placed in a more equable climate than our own. The labour, however, connected with the combination and working out of continuous registers for many years is so great, that the work to be done is almost beyond the means of individual observers. At the same time, I think such results from a good number of places, reduced alike and connected together, would do more to advance meteorology than any other class of observations.

In this discussion I have made no reference to the pressure of the wind, or to its strength generally; this I must defer to a future time.

III. *Report of a Cyclone at Montserrat, on July* 7, 1861. By the Honourable Samuel Cockburn, Governor of the Island. Communicated by Dr. Lee, F.R.S. &c.

[Abstract.]

For a few days the weather had been wet and gloomy; but the glasses kept pretty steady, the thermometer varying from 78° to 84°, and the barometer from 29·79 to 29·82. At 4 A.M. on July 6, the barometer *suddenly* fell 0·07 of an inch; and I immediately suspected a storm was approaching.

The breeze was blowing gently from the *north-east* as usual. About 5 o'clock it freshened, and from 6 to 8 it blew a violent gale, a thick fog covering and darkening the whole land. About 7 a waterspout from the south came whirling along over the sea and burst in front of the port. At 9 the glass rose 0·01, and the wind began to abate, clearing up a little; at 11 it lulled; and at 12 there was a treacherous calm. The barometer suddenly fell again 0·04, indicating the *second* part of the hurricane. At 12.30 P.M. the glass further sank 0·04; and at 1 it began to blow again in gusts more violent than before, but from the *opposite* point, namely the *south-west*, accompanied with thunder, lightning, and rain, the house shaking fearfully, the sea boiling up and mingling its roar with the howling of the wind, and bursting in heavy surfs upon the shore.

At 3 the barometer rose 0·01; at 4 the wind began to abate till 5, when it ceased altogether, while the glasses continued to rise slowly till all was over.

From the foregoing I draw the following conclusions:—

1. That a *whirlwind*, coming from the *south-eastward* and revolving from *right* to *left*, struck this island on the morning of July 6, with the wind from the *north-east* (gradually veering towards the *east*); then it lulled, and after a while commenced again (but *south-easterly*), and ended from the *south-west*.

2. That the breadth of the whole *cyclone*, that is the diameter of the circle described by the whirlwind, is equal, *in time*, to twelve hours: namely, the breadth of the *anterior* part four hours (from 5 to 9 A.M.); the breadth of the *hollow*, in the *centre of the cone*, where there was *no wind*, four hours (from 9 A.M. to 1 P.M.); and the breadth of the *posterior* part four hours (from 1 to 5 P.M.); equal to the whole duration of the hurricane, proving that its *centre* must have passed over the island. It only remains to compare the corresponding intervals at some of the islands which it

visited to arrive at the velocity and the extent in *space*; and having the direction, one may at once easily tell the islands over which it passed.

Here, fortunately, it did no injury beyond blowing away a few points of the windmills in the country, unshingling a few old houses, and slightly damaging and drifting the vessels in port, and scattering about a few boughs of trees.

It must have come from Guadaloupe, &c., swept over Antigua, and proceeded hence to Nevis, St. Kitts, &c. I await accounts from abroad to test the accuracy of my conclusions, and would be glad of any information on the subject.

Extract from Meteorological Register.

	Thermometer.	Barometer.	
	°	in.	
July 6, 3 A.M.	81	29·80	Gloomy; wind N.E.
4 A.M.	80	29·73	Gloomy; rain; wind N.E.
5 A.M.	79	29·73	Wind increasing.
6 A.M.	79	29·73	Rain and wind; a gale.
7 A.M.	79	29·73	Rain and wind; a gale.
8 A.M.	78	29·73	Rain and fog (W. veering easterly).
9 A.M.	77·75	29·74	Thick fog; barometer rising.
10 A.M.	77·75	29·74	Weather abating.
11 A.M.	77	29·74	Lull, and clearing up.
12 Noon	76·50	29·70	Calm; barometer falling.
12¼ P.M.	76·50	29·66	Fog again; barometer falling.
1 P.M.	76·50	29·66	Lightning; thunder; rain.
2 P.M.	76	29·66	(Wind S.E.) increasing.
2¼ P.M.	76	29·66	A gale; wind S.W.
3 P.M.	77	29·67	A gale; wind S.W.; barometer rising; house all closed up; quite dark; obliged to light a candle.
3¼ P.M.	77	29·68	
3¾ P.M.	78	29·72	
4 P.M.	78	29·72	Abating.
4¼ P.M.	79	29·74	Ended.
5 P.M.	79	29·74	Calm.

Elevation about 300 feet above sea-level.

No correction made for position, &c.

The magnetic needles fluttered occasionally during the gale, but I noticed no very marked oscillations.

The instrument is a mercurial barometer by Casella and Co., and proved very sensitive. I have two others, but not so good. I have no aneroid.

IV. *Rainbow Phenomenon.* By J. Matthew, Esq.

St. David's College, Lampeter,
6 November, 1861.

Dear Sir,—Some weeks ago I witnessed a meteorological phenomenon which to me was new and striking, as well as inexplicable; though probably there is nothing in it worth mentioning to you.

On the 25th of September last I was at the Mumbles, a village on the sea-coast five miles from Swansea. About 5 p.m. the sun was descending in a perfectly bright and clear sky, while the whole eastern hemisphere was covered with a dense black rain-cloud, on which were projected two very brilliant rainbows. When first seen, the arcs of these bows were short; but my attention was arrested by a coloured luminous spot between them. The singularity of the appearance induced me to continue my observation, and I was surprised to find that as the arcs of the rainbows lengthened, so did this bright spot, until at length it formed an arc extending nearly from one bow to the other, with its curvature in an opposite direction to that of the bows. The arrangement of the colours was the same as in the primary (*i.e.* from right to left); but as, perhaps, a rough sketch may give you a clearer idea than words, I enclose one copied from a sketch I made at the time.

I have not been able to find, in any books I possess, any notice of such a phenomenon, nor do I see any clue to its explanation: if you can, without trouble, give me any information on the subject, I shall feel much obliged. I am, dear Sir,

Yours very faithfully,

James Glaisher, Esq. J. Matthew.

V. *Development of a Horary Periodic Formula for determining the Height of the Barometer, Dry and Wet Thermometers, Dew-point, and Elastic Force of Atmospheric Vapour*: derived from the Greenwich Meteorological Observations for 1856. [10 October, 1861.] With a Supplement containing *Observations made at Greenwich on the Underground Thermometers in the year* 1859. [19 November, 1861.] By S. M. DRACH, Esq., F.R.A.S. Communicated by HENRY PERIGAL, jun., Esq., F.R.A.S.

[Abstract.]

THE memoir, consisting of twenty pages, contains a formula, $H=H_0+A\sin t+a\cos t+B\sin 2t+b\cos 2t+C\sin 3t+c\cos 3t+E\sin 4t+e\cos 4t+F\sin 5t+f\cos 5t+G\sin 6t+g\cos 6t+K\sin 7t+k\cos 7t+M\sin 8t+m\cos 8t+N\sin 9t+n\cos 9t+P\sin 10t+p\cos 10t+Q\sin 11t+q\cos 11t+R\sin 12t+r\cos 12t$.

Wherein H denotes the height of the barometer, degrees of the thermometers, &c. for any time t after the epoch; H_0 the value of H at the epoch (computed for midnight).

To adapt the formula to a noon epoch, it is only necessary to change the signs of the odd time factors A, a, C, c, F, f, K, k, N, n, and Q, q, which produces the modification exhibited.

The numerical values of A, a, B, b, &c. are given in the memoir for the five instruments, and according to the set of coefficients substituted in the formula; H expresses the height of the barometer to 0·0001 of an inch; the degrees of the dry or wet thermometer, or dew-point instrument, to 0°·001; and the elastic force to 0·00001: the time t being converted into arc at the rate of 15° per hour.

The determinations above are followed by fifteen tables, three for each instrument, which exhibit—

1st. The values of the coefficients 24 A, 24 a, &c. for each date.

2nd. The values of $\sqrt{A^2+a^2}$, and a constant angle derived from the coefficients, taken to the nearest 0° 1′ by Raper's six-figure logarithms.

3rd. The multiples of the lower terms, with a view to ascertain how far the angular portion is compressible.

VI. *New Barometer.* By Mr. R. Howson.

This instrument was exhibited to the Members at the Meeting, and described by the author. A detailed account, drawn up by the inventor, with a drawing, will be found in a subsequent page (p. 81) of this Number.

VII. *Mercurial Minimum Thermometer.* By Mr. L. M. Casella, jun.

Dr. Thompson directed the attention of Members to this instrument, and exhibited one. He spoke favourably of the behaviour of this thermometer as far as his observations had extended and gave a general description of its arrangement. In the conversation which followed, Mr. Casella described it more fully. A drawing is given in a subsequent page (p. 80) of this Number, with a detailed account, approved by Mr. Casella.

BOOKS AND NOTICES.

I. *Meteorological Papers, published by Authority of the Board of Trade.* Compiled or edited by Rear-Admiral FitzRoy, F.R.S. &c.

During the present year six Numbers of these papers, namely Nos. 5 to 10 inclusive, have been published, together with a Second Edition of the third Number. A volume of Plates has been issued with the tenth Number.

The Meteorological Department of the Board of Trade was established in 1855; a Report from this Department was presented to both Houses of Parliament in May 1857. During the years 1855–57, a series of Wind Charts was completed and circulated in the Navy and Mercantile Marine. A Report, dated 1858, June 22, was addressed to the President of the Board of Trade, and subsequently printed.

A brief notice of the nature and contents of these papers is given for the information of the Members of the Society.

First Number, 1857. 4to. 182 pp. Sixteen Plates.

The contents are:—"Indicatory Letters and Figures to denote the state of the Weather and Force of the Wind." "Meteorological Observations at Bermuda, 1853–54; at Halifax, 1854–55; at Ascension, 1854–55; at Valparaiso, 1853–55; at Ceylon,

Point de Galle, 1854; Trincomalee, 1854; and Colombo, 1854:" diagrams, in illustration of these observations, are included among the Plates. "Notice of a Typhoon in the China Sea on May 19, 1855." "Abstract of Deep-Sea Temperatures, obtained on board H.M. Surveying Schooner 'Saracen,' from Madeira to the Cape of Good Hope, February 25 to April 17, 1858." "The Directions for making Meteorological Observations at Sea, in accordance with the decision of the Brussels Conference in 1853." "The Meteorology of New Zealand; of the Cape of Good Hope; of Mauritius; of the Isthmus of Darien and Carthagena:" diagrams accompany the Mauritius observations. The volume concludes with a "Memorandum on the Use and Adjustment of Instruments at Sea"—compasses, sextants, chronometers, barometers, or sympiesometers, and thermometers. In addition to the subjects already mentioned, the Plates include—a Form for Registering Observations on Land —Specimens of Wind Charts—Trade-Wind Chart—Black Sea Wind Chart—Diagrams of Balaclava Storm of November 14, 1854. Many of these are large folding Plates.

Second Number, 1858. 4to. 40 pp.

The contents are:—"Introductory Remarks by the Compiler or Editor of these Papers," Rear-Admiral FitzRoy, F.R.S. Then follows a Table, arranged in alphabetical order, intended to show the shortest and the average length of passages (in days) between any ports frequented by sailing ships, by full-power steamers, and by mixed or auxiliary steamers, using sails; and giving also the shortest track in sea miles. Then follows a Table of Distances or Arcs of Great Circles, in geographical miles. "An Abstract of General Sailing Directions," containing remarks on—Preparing for Sea—Swinging Ships for Deviation—Chronometers—Putting to Sea or approaching Land—Tides—Wind and Weather—Weather-glasses — Thermometer and Hygrometer — Common Signs of Weather—Aneroid Barometer—Sympiesometer—Great Circle Sailing—General Oceanic Directions. To which is added a "Comparison of Sailing (only), and Sailing with Auxiliary Steaming in long Voyages," by Lieut. M. F. Maury, LL.D., U.S.N.

Third Number, 1858. 4to. One Plate.

The greater portion of this Number (73 pages) is occupied by a translation, made by the Authority of the Board of Trade, of Prof. Dove's "Law of Storms," edited by Rear-Admiral FitzRoy; with Notes by the Editor; and illustrated by a folding Plate of Storm Charts, and several woodcuts.

The Appendix to this Number contains:—A Card to accompany Weather-glasses—References to Remarks on Storms, published in 1838—Extracts from the "Barometer and Weather Guide," a popular Manual that had just previously been published in small 8vo, 25 pp., by the Board of Trade, and of which a second edition on thicker paper and larger type was published in 1859, 8vo, 22 pp.

—Letter from Prof. Espy, referring to the first Number of these Papers, and to his own "Fourth Report on Meteorology," and requesting the Board of Trade to appoint a Committee to examine his Report. This letter is followed by "Facts, and the Conclusions to which they lead," submitted by the Editor of the paper.—"Remarks on Aqueous Vapour," translated from the Abstracts of Meteorological Observations taken by the Royal Engineers in 1853–54, and edited by Col. H. James, R.E., F.R.S.—"Suggestions intended to promote Correspondence between Meteorological Observers," including Col. James's "Table of the Velocity and Pressure of the Wind."

A *Second Edition* of this Third Number was published in 1861, containing some Notes contributed by Sir F. W. E. Nicolson, Bart., R.N.

Fourth Number, 1860. 4to. 61 pp. Two Plates.

This Number contains:—an "Abstract of Meteorological Register of the Arctic Discovery Yacht 'Fox,'" Capt. (now Sir) F. L. M'Clintock, R.N., kept by D. Walker, Esq., M.D.; with Map of the Arctic Regions. The Preface by the Editor contains a Letter from Capt. M'Clintock, dated Holsteinberg, South Greenland, May 5, 1858; including a Table of the Wind and Ice Drift experienced by the Arctic Searching Yacht 'Fox.' Appended to the Register is a Chart of the Barometer Range (uncorrected) in the month of January 1858, in Baffin's Bay.

The Appendix contains:—a "Description of the Marine Barometer, adopted by H.M. Government" on the recommendation of the Kew Observatory Committee of the British Association for the Advancement of Science—"Testing Barometers, Hydrometers, and Thermometers."

Fifth Number, 1861. 4to. 99 pp. Three Plates.

This Number contains a selection from a series of "Meteorological Observations, 1858–59, made by Dr. Mann at Natal," which were transmitted to this country and voluntarily offered to this Department of the Board of Trade. The Tables are prefaced by Notes on Dr. Mann's Observations, and Remarks on the upland summer of Natal, by Dr. Mann. Then follows "Meteorological Observations at Orotava in Teneriffe," from Prof. C. Piazzi Smyth, F.R.S., 1856–57. They were made by M. Franz Kreitz, with the Board of Trade instruments, provided through Admiral FitzRoy.—"Meteorological Observations at Papiete in Tahiti, 1855–60."—"Temperatures at Japan, taken at the Island of Decima, the foreign quarter of Japan, 1845–55." Madeira and Decima are in about the same latitude, and both about equidistant from a great continent; but, according to some Dutch remarks, which have been translated by T. H. Babington, Esq., Madeira presents an "island climate," and Decima a "continental type," which is accounted for by one being on the *east*, the other on the *west* of a large tract of land. A comparison between the mean temperature

of each month at Funchal (Madeira), Decima (Japan), and Oglesthorpe (Georgia). The difference between the summer and winter temperatures of the three places are 8°·4, 33°·4, and 26° respectively. This Number concludes with "The Climate of Orkney," by the Rev. C. Clouston. This paper has also been published separately, 4to, pp. 15. Some Introductory Notes by Mr. G. H. Simmonds are given.

Sixth Number, 1861. 8vo. 39 pp. Two Plates.

This Number contains a paper by Prof. Dove "On the Periodical Variations of the Pressure of the Atmosphere," translated for the Meteorological Department of the Board of Trade. It was read before the Royal Academy of Sciences, Berlin, on Nov. 12, 1860. The conversions to English measures have been made by Mr. G. H. Simmonds.

Seventh Number, 1861. 4to. 18 pp. One Plate. One woodcut.

The subject of this Number is the "Intertropical Diurnal Range Table of the Barometer." In the Preface, Admiral FitzRoy says, "By these Tables a value or correction may be obtained for barometrical observations made on board any ship crossing the equator at the present time or *in any former year*; the margin or limit of error not being greater than that allowable in ordinary observations made by various persons at night, as well as during the day time, on board a ship in motion at sea."—Aug. 1861.

Eighth Number, 1861. 4to. 83 pp.

"Anemometry at Bermuda, from April 1859 to September 1860," forms the substance of this Number. There is a Preface by the Editor, who says that "In 1856 representations were made to the Board of Trade by the Royal Society and British Association, that it was very desirable to effect a series of anemometrical observations at certain selected places in the Atlantic or on its coasts. The Board of Trade consented to send a thoroughly efficient instrument to Bermuda, and the Admiralty agreed to place its equal at Halifax. Early in 1859 these two valuable anemometers, having been some time fixed and accurately verified at Kew, were conveyed by Mr. Babington to their destination, and were by him placed satisfactorily." The records were reduced and tabulated by Mr. Symons, who says, "The instrument, from which the following observations have been obtained, consists of three principal parts,—Robinson's cups for the determination of velocity and force, a double windmill governor for direction, and a clock turning the cylinder, with paper attached, on which two pencils (spirals) mark the registrations." A full description (with engravings) of this Anemometer is given by Mr. Beekley, of the Kew Observatory, in the 'British Association Report' for 1858, pp. 306–7, plates 19 and 20.

The Appendix contains certain memoranda, dated February 23

and June 21 and 22, 1859, requesting that information respecting wind and weather (particularly) might be obtained and transmitted to this Department during the eleven following months; and directions are given.

NINTH NUMBER, 1861. 8vo. 78 pp.

The contents of this Number are "Miscellaneous;" a few meteorological fragments, as mere notices in a portfolio, rather than elaborate or scientific expositions.

I. "Remarks on Meteorological Progress."—Admiral FitzRoy mentions the arrangements made in 1857 to collect simultaneous observations from selected stations in the British Islands and the Continent, and forward them to London by electric telegraph. This system was commenced in September 1860. Until January 1861 it was limited to *receiving* reports from practising observers. On February 6 the first *warnings* of expected rough weather were transmitted by telegraph to seaport towns. Several vessels were wrecked on February 8 and 9 from Shields, where the warning was disregarded. Eight other warnings were given between that date and March 19. Whether from these storm-signals having been appreciated, or from other reasons, the *fact is* that very few wrecks occurred on our coasts during that tempestuous period. The warning-signals are described, and the mode of dealing with them explained.

II. "Memoranda of Mr. Rush's ascent in a balloon in 1838," as recorded and written by Mr. Green.—The ascent took place from Vauxhall on September 10, at 6.30 P.M. The descent at Lewes, a distance of fifty miles, at 7.45. To this article is added, "Remarks by Mr. Green's friend in 1838, extracted from a periodical publication," containing reports of several other ascents.

III. "Portable Cup and Dial Anemometer," made by Mr. Adie of London and Edinburgh.—The principle on which this instrument is constructed is "that the centre of any one of the cups moves with a third of the wind's velocity;" and the dimensions are so adjusted that "500 revolutions of the cups are produced by a mile of wind."

IV. "Helm (or Holm?) Wind."—"A rolling cloud, sometimes for three or four days together, hovers over the mountain tops, the sky being clear in other parts. When this cloud appears, the country people say the *helm* is up; which is an Anglo-Saxon word, signifying properly a covering for the head, from whence comes the diminutive *helmet*. This helm is not dispersed or blown away by the wind, but continues in its station, although a violent roaring hurricane comes tumbling down the mountains, ready to tear up all before it. Then on a sudden ensues a profound calm, and then again alternately the tempest, which seldom extends into the country above a mile or two from the bottom of the mountain." —*Nicholson and Burns's Westmoreland.* Similar appearances near the Cape of Good Hope have been described.

V. "Ice in a Squall."—On January 3, 1860, in lat. 38° 53′ S.,

long. 20° 45′ E., a heavy squall struck H.M.S. 'Simoom,' accompanied with much rain and large pieces of ICE, weighing from 3 to 6 ounces, very irregular in shape, some being covered with sharp points, and others being in flat slabs.

VI. "Remarkable Halo;" seen 1861, April 21, from H.M.S. 'Agamemnon,' becalmed off Cape Bianco (Corfu).

VII. "Baltic Observations."—There is a letter from C. Piazzi Smyth to Admiral FitzRoy, describing the behaviour of the barometer and the aneroid, and saying in conclusion, "it does so far bear out your view of a something in the atmosphere which acts, and powerfully, on the 'metallic' aneroid barometer, and not at all on the mercurial." Captain David Steele also noted that "the metallic barometer began to rise, while the mercurial barometer never moved till the following morning at 4 A.M., when it fell, after a storm had subsided, the approach of which had not previously been indicated by any fall in the barometer, while the metallic barometer belonging to the ship kept falling all day." Admiral FitzRoy suspects "that an electrical (or chemical) change in the atmosphere, caused by an approaching current of a nature different from the air above the observer, is felt and shown by oil, gas, steel, brass, &c., though not by mercury, so long as the change does not affect pressure or (to any great extent) temperature."

VIII. Sir Thomas Maclear writes from the Cape of Good Hope, on March 18, 1861, to Admiral FitzRoy, stating that he intends to commence "printing the Cape Meteorological Observations from 1860, January 1." He has been occupied in comparing barometers with standard barometers compared with the Greenwich standard by Mr. Glaisher, and sent out; also Kew standards from the Board of Trade.

IX. "New Marine Barometer."—These barometers "are packed with vulcanized india-rubber, in order that (by this, and a peculiar strength of glass tube) guns may be fired near them without causing injury by ordinary concussion." The scale is porcelain; there is no iron anywhere (to *rust*); every part can be unscrewed; there is a spare tube filled and fixed in a cistern. The behaviour of various barometers of this construction under fire is described by Captain Hewlett. Mr. Negretti was present during the experiments.

X. "Remarks on Gales, Storm-signals, and Weather Tables." —The Editor refers to the "Weather Report" which is now published daily; and to the "Storm-signals," which are sent with prudence and caution to seaport towns, when occasion requires; and he gives examples.

XI. "Additional Observations on Weather and Meteorological Instruments, with the use of Daily Tables."—Towards the conclusion of these observations, Admiral FitzRoy says, "An attempt may here be made, however slight, to an investigation of some causes of the late anomalous summer. Last year the coasts of Greenland were blockaded with ice to an extent unknown for about thirty years. That ice was loosened *from further north*, and drifted after the hot season of 1859. In last year, as the polar air-

currents, or the *mixture* of polar and westerly winds, reached Europe from the *north-westward*, they were affected on a vast scale, as the smaller streams of air are by passing over a melting iceberg; and consequently we had a year of unusually low temperature, with much rain, more rain indeed than had fallen for some *thirty* years,—about the *same* interval that the Greenlanders *estimate* as having occurred since their coasts were similarly shut up by ice for a whole summer."

XII. "Considerations and Suggestions."—The considerations are in order to assist in explaining the laws to which all storms are accordant. The precise objects of the "Daily Weather Table" are stated.

XIII. "Memorandum respecting the Moistened Thermometer (Damp- or Wet-bulb) used in comparison with a dry one, as a Hygrometer, on Mason's principle."

XIV. General Sabine and Professor Henry.—Professor Henry writes to General Sabine that *in America weather reports are collected by the aid of the electric telegraph*, and the results exhibited, as they arrive, on a large map, by discs coloured differently, according to the weather. He says, "When our reports are full, particularly from points West of this city (Washington), we scarcely ever fail to foretell, for nearly a day in advance, the state of the weather." He has published a series of meteorological essays, including one on 'Atmospheric Electricity.'

XV. "Forecasts of Weather."—The object of this Note is to explain what is actually attempted by this Department, as well as the principles by which the *forecasts* of weather are regulated.

"Additional."—This is an extract furnished by Mr. Green from one of his papers, dated July 13, 1850, of his "Balloon ascent from Leicester," July 6, 1850, accompanied by Mr. Rush.

TENTH NUMBER. 8vo. 88 pp. Five Plates. Accompanied by an Atlas in 4to of Twenty-six folding Plates.

This Number contains:—"British Storms: Outline notices of remarkable instances—'Royal Charter' and other recent Storms." The two storms selected for illustration are the storm of October 26–27, 1859, during which the 'Royal Charter' was lost; and another storm on November 1–2 of the same year. A paper by W. Stevenson, Esq., of Dunse, 1853, "On the interference of following or consecutive Cyclones," is reprinted, illustrated by a woodcut.

"Preparations for simultaneous or synchronous observations. Occurrence of remarkable storms. Means of investigation. Astronomer Royal's assistance."—The preparations were made and instructions circulated in the July preceding, and were in satisfactory operation when these storms occurred. Hence it occurred to Admiral FitzRoy, that having "such a collection of facts as could not have been accumulated on any former occasion of the most remarkable storm," he "ought to treat this one, evidently cyclonic, in full detail." The Greenwich observations from October 20 to

November 10 are given; the curves are laid down, and beside them the Oxford curves. The Camden Town observations, made by Mr. G. J. Symons, are given.

"Character and effects of seasons immediately preceding Autumn 1859. Connexion of electrical or magnetic actions with storms. General Sabine and Professor Loomis on Auroras. Synchronous Charts."—The twenty-six synchronous wind-charts contain "ample details of atmospheric changes or states over the British Islands, and parts of sea and land near them, from the 20th of October to the 10th of November inclusive." "Every detail of the charts has been laid down or plotted with mathematical exactness, and correctly, as far as the data permitted." The direction of the wind is shown by short black lines, with a dot at the end from which the wind blows. The length of the line is in proportion to the force. Barometric pressure is indicated by a single dark line. Its distance from a named base-line, on an inch scale, gives the height. Temperature is shown by a single light line, and its distance, as described, from a base-line. Cloud is indicated by small curves; rain, by vertical lines; snow, by horizontal lines; hail, by broken alternate lines; fog, by dots; from one to four groups of either, for the relative proportions. Broken wind-lines, direction, not force; broken circles, calm or light variable breeze. A short analysis is given of the features presented by the charts in succession; and the general impression they convey as to "the gyratory movements of wind, usually called cyclones."

Admiral FitzRoy describes the origin of the instrument popularly known as the "Storm-glass." "Some forty years ago an Italian named Malacredi introduced* what was called a 'storm-glass' into this country. He was then with Mr. Troughton, the well-known optician;" and is "well remembered by the Agent for the Admiralty and Board of Trade Publications, Mr. Potter, 31 Poultry, London." The Admiral has satisfied himself that the contents of these glasses vary in character with the direction of the wind and its electric tension. He describes the features presented under various conditions of wind, &c.

Appendix.—A reprint is given from 'Silliman's Journal' of the last of seven articles by Professor Elias Loomis, "On the Auroral Exhibition, and its attendant phenomena, from August 28 to September 4, 1859."

"On Storms and Circle Sailing;" being a paper read before the Liverpool Literary and Philosophical Society by Mr. Thomas Dobson, B.A., Head Master of the School-frigate 'Conway.'

A letter from Admiral FitzRoy, dated January 14, 1860, to the Editor of the 'Scotsman,' in reference to "Dove's Law of Gyration; and to Electrical Action;" and a reply. Some ship registers of weather during the 'Royal Charter' storm conclude the Number.

[The ten Reports have been presented to the Society.]

* Admiral FitzRoy has since learned that Malacredi was preceded by Corti, who seems to have been the originator.

II. *Magnetic Storms and Earth-Currents.*

WALKER—'Philosophical Transactions of the Royal Society,' vol. cli. part 1. pp. 89–132. 1861, February 14.

AIRY—'Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich,' p. 14. § 9. 1861, June 1.

DE LA RIVE—'Archives des Sciences Physiques,' nouvelle période, tom. vi. pp. 49–59; pp. 275–288. 1859, September 20 and November 20.

SECCHI—Ibid. tom. xi. pp. 110–136. 1861, June 20.

LAMONT—Ibid. tom. xii. pp. 76–79. 1861, September 20; and Letters to Astronomer Royal, 1861, July 29 and August 24.

LOOMIS—'American Journal of Science and Arts,' vol. xxviii. pp. 385–408; vol. xxix. pp. 92–97, 249–266, 386–399; vol. xxx. pp. 79–89; vol. xxxi. pp. 3–25; vol. xxxii. pp. 1–14, and 318–335, being in the Numbers issued 1859, November; 1860, January, March, May, July, and November; 1861, July and November.

Mr. C. V. Walker, one of the Secretaries of this Society, confined his attention chiefly to observations made by himself or under his direction in the south-eastern district of England. He discussed the observations and communicated the results to the Royal Society. Certain days were selected when earth-currents were powerful and abundant. As far as these observations went, the conclusions to which they lead are:—

1st. That the prevailing direction in which currents are travelling in the earth during periods of great magnetic disturbance is from about N.E. to about S.W., or *vice versâ*. The actual place is somewhere within an arc of 31°, comprised between $24\frac{3}{4}°$ and $55\frac{3}{4}°$ E. of N., or *vice versâ*.

2nd. That the S.W. currents were as frequent—of as long duration—and of equal value with the N.E.

3rd. That the disturbance of magnetometers during such seasons is in a direction in accordance with the then prevailing direction of the earth-currents; and that the current acts directly on the needle.—1861, February 14.

[A copy of this paper is placed in the Library.]

The Astronomer Royal reports:—"I alluded in the last Report to the possible establishment of galvanic wires which would record, perhaps, upon the same photographic sheets which bear the declination and horizontal force, the magnitude and direction of earth-currents in two directions. I conceive that this may be justly regarded as an important physical experiment; and I hope to be able shortly to lay before the Visitors some details of plan, and to ask their opinion in a more precise form."—1861, June 1.

It may be mentioned that the opinion of the Board of Visitors was taken, and that they approved of the proposition. It was then submitted to the Admiralty; and the grant of money necessary for carrying it out has been obtained. Dartford and Croydon

have been selected as the places where the Greenwich wires will terminate. Mr. Walker is preparing to erect the wires, all arrangements being completed.

Professor De la Rive has written two Notices on the phenomena that accompanied the Aurora Borealis of 1859, August 29; and those of September and October. He refers to the disturbances of the telegraph in France, in Switzerland, and elsewhere; and to the magnetic disturbances, which were also so remarkable during the period in question. He regrets that observations of earth-currents so few and so indefinite reached him. From the materials before him he was led to infer that the prevailing direction of the earth-current proper is *from* the northern regions; and that the currents in the reverse direction, which, from the returns before him, appeared to be "of less intensity and of less duration," were due to "the secondary polarities acquired by the two plates of copper that are thrust into the ground after they have been transmitting for a few moments a derivation of the terrestrial current." He considers that the direction of these currents is that of the terrestrial meridian; and that "if the centre of the aurora borealis is the magnetic and not the terrestrial pole, it is because the action of terrestrial magnetism causes the currents that are in the air to deviate; and which being perfectly mobile, easily obey the action of a foreign force."—1859, September 20 and November 20.

Professor Secchi has published a Memoir "On the Connexion of Meteorological Phenomena and Variations of the Intensity of Terrestrial Magnetism."

He believes "*that we must absolutely admit the mutual dependence of magnetic variations and meteorological variations.*" He adds, "The accuracy of the following principles is beyond doubt:—

"1st. Every rupture of meteorological equilibrium which produces a condensation or a rarefaction of vapours, produces a rupture of electrical equilibrium.

"2nd. The equilibrium of this agent can only be re-established by means of a current which discharges itself from place to place upon the surface of the earth.

"3rd. This current cannot fail to act upon the magnetometers, and to be indicated by them."

He gives thirteen pages of "Comparison of Magnetic and Meteorological Variations." He says, "It appears that there are two classes of disturbances; *auroral* disturbances, and the ordinary meteorological disturbances, which are caused by *tempests*."

"In this first essay upon this subject," he says, "I protest that I do not pretend for a moment to establish definite laws; I will simply leave to the judgment of philosophers the task of deciding whether the proofs are sufficient or not."

The phenomena which led him to suspect the relations in question are:—

That the instruments are more disturbed in winter than in summer.

That the bifilar and the vertical force instruments vary much from the mean during bad weather.

The indications of these instruments increase greatly when cold and violent winds blow, even when the declinometer does not vary; the reverse with south winds.

The bifilar, from its delicacy of construction, is sensible to all the small atmospheric variations, even when they are of short duration.

He thinks that "atmospheric electricity may eventually be revealed as the veritable and only principle upon which depend magnetic variations, which are still so mysterious in their origin." He has "constructed an apparatus for measuring atmospheric electricity, which" he "has always found to be very intense during disturbances."—1861, February 3.

Dr. Lamont has employed in the observations of earth-currents "wires of different lengths, and metallic discs of different sizes; in all cases the currents are the same, but their intensity depends on the size of the discs and the length of the wires, or rather the distance at which the discs are placed from each other."—1861, July 29.

He considers that the currents are due "partly to the agency of *chemical causes*, partly to *thermal causes*, partly to terrestrial electricity." He believes "that lines above 1000 feet in length, if not under ground, are of no use for the investigation of terrestrial electricity, because under all atmospheric circumstances the disturbance produced by thermo-electric currents will be too great." He thinks that "the first thing to be done now is to find the means of separating the effects of terrestrial electricity from other causes; and then the nature of the electric currents and their dependence on local and atmospheric circumstances must be ascertained." By an arrangement of wires which he describes, he adds, "it would be possible, by simultaneous observations, to decide all the important questions relating to the parallel motion of electric waves, their coincidence with the magnetic variations, the influence of change or resistance in the soil, the influence of changes of temperature, humidity, &c."—Aug. 24, 1861. He finds by observation "that different parallel lines manifest identical currents. From this it must be concluded that *there exists an electric current which is propagated parallelly on the surface of the earth, whatever be the nature of the soil.*" He notes that an E.-W. current corresponds with an augmentation in magnetic intensity; and "when the galvanometer indicates a current from the north to the south, the western declination undergoes an increase." The proposition to which he arrives is, that "*magnetic variations which are manifested at short intervals are produced by the terrestrial current.*" On account of the continued changes of temperature and humidity, both in the metal earth-plates and in the conducting wires, he has placed the latter under ground and beyond the immediate influence of heat.—1861, September 1.

Professor Elias Loomis, of Yale College, has published a series of eight articles "On the Great Auroral Exhibition of August 28 to September 4, 1859; and on Auroras generally." He has collected a very large amount of information from all parts of the world —magnetic disturbances, earth-currents in telegraph wires, aurora borealis and australis. From the combination of observations, he deduces "that *the upper limit* of the auroral light (1859, August 28) was elevated 534 miles above the earth's surface, and that its southern margin was vertical over the parallel of 36° 40′ North lat. in Virginia." He finds by a like process "that *the upper limit* of the auroral light (1859, September 2) was elevated 495 miles above the earth's surface, and that its southern margin was vertical over the parallel of 22° 30′ N. lat. in Cuba." The belt of light "pervaded the entire interval between the elevations of 50 and 500 miles above the earth's surface. This illumination consisted chiefly of luminous beams or columns, everywhere parallel to the direction of a magnetic needle when freely suspended. These beams were therefore about 500 miles in length; and their diameters varied from five to ten and twenty miles" and upwards. The magnitude of the earth-currents in America was such that "brilliant sparks were drawn from the telegraph wires;" "a flash was seen about half the size of an ordinary jet of gas;" "a spark of fire jumped from the forehead of a telegraph operator when his forehead touched a ground wire;" "streams of fire were seen when the telegraph circuit was broken;" "a flame of fire followed the pen of Bain's chemical telegraph." In Norway "sparks and uninterrupted discharges were observed;" "bright sparks were noticed on the conductors of the telegraph lines to Bordeaux;" "paper and even wood were set on fire;" "magnetic helices became so hot that the hand could not be kept on them;" "the heat was sufficient to cause the smell of scorched wood and paint to be plainly perceptible;" "a flame of fire burned through a dozen thicknesses of paper; the paper was set on fire and produced considerable smoke." In Norway "pieces of paper were set on fire by the sparks; and it was necessary to connect the lines with the earth in order to save the apparatus from destruction;" "some of the telegraph operators received severe shocks when they touched the telegraph wires;" "at Washington the telegraph operator received a severe shock, which stunned him for an instant;" "on several lines it was used as a substitute for a voltaic battery in the ordinary business of telegraphing;" "the intensity of this effect was estimated to have been at times equal to that of 200 cups of Grove's battery;" "in Switzerland the currents were at least threefold the ordinary current employed in telegraphing."

He gives a Table of Telegraph lines in America, their directions, and the angle they make with the N.E. line of direction; and says, "At present we can only infer that all the facts reported are consistent with the supposition of electric currents moving to and fro on the earth's surface, whose average direction was from about N. 45° E. to S. 45° W.;" and that "Mr. Charles V. Walker,

from a discussion of these and other similar observations, has arrived at the conclusion that in the S.E. part of England *there is a stream of electricity of indefinite width drifting across the country, moving to and fro along a line directed from N. 42° E. to S. 42° W.*"

He has consulted the volume published by the Magnetic Association, and noticed the remarkable similarity of the curves at places far apart; and has given a long Table of "Observed deflections of the horizontal magnetic needle," when there was a well-marked maximum or minimum value and of short duration; and Tables giving a summary of the cases when these maxima or minima occurred before, after, or simultaneously with that of Göttingen. By drawing a circle through Göttingen with the early-recurring maxima or minima on one side, and the late-recurring on the other, he obtains a direction of "about N. 62° W. to S. 62° E., indicating a progress of the electric wave" "over the surface of Europe in a direction from N. 28° E. to S. 28° W." "It is possible," he adds, "that a more extended series of observations would show that these two directions" (his own and Mr. Walker's) "are identically the same; but it is not improbable that the direction in England is somewhat different from that in central Europe." There was a difficulty in "determining the average rate of the progress of the electric wave." Comparing Dublin and Göttingen time of max. or min., the result was 2700 miles an hour; substituting Upsala for Dublin, the result would be 11,000 miles. "Sometimes the observations may be explained by supposing a single broad current of electricity flowing over Europe from N.E. to S.W. Occasionally the progress appears to be mainly from S.W. to N.E."—1861, September.

III. *Greenwich Magnetical and Meteorological Observations*, 1859. Royal 4to. Pp. ccxxvi.

The Greenwich volume just issued contains "Reduction of the Magnetic Observations from 1848–57." The days on which "great magnetic disturbance" occurred are rejected, as well as other days, "on account of defect of adjustment, loss of photographic trace, &c." "No mean" was taken "for a day, unless the series of twenty-four readings were complete." The mean annual diminution of western declination "appears as 7′·9." "There is most clearly no increase of westerly declination in the summer months." In one of the Tables (Table V.) the varying character of the diurnal inequality of declination through the months of the year is exhibited. "The double diurnal fluctuation is clearly shown" in another Table (VI.). Another Table (XI.) "gives the diurnal inequality of horizontal force for each year, the quantities for different months in the same year being grouped and the mean taken." "There is a well-marked diminution of force in the day, with an increase in the night. The horizontal force is smallest a little before 23^h Greenwich mean solar time."

"It is evident that the two diurnal inequalities are related quantities, produced by different resolved parts of the same force." A diagram is given "explanatory of the magnitude and direction of the forces acting on the north end of the magnet at Greenwich at different hours of the solar day." The following remarks are in the words of the Astronomer Royal:—

"Now, if we combine together these various considerations,—(1) that the diurnal force is undoubtedly connected with the sun; (2) that it is very different on different sides of the meridian, showing that the sun does not produce it immediately, but mediately by his influence (probably) on different parts of the earth; (3) that the great difference in the magnitudes of diurnal force in the summer and the winter (the proportion being nearly 2:1) seems to show that the mediately active part of the earth must be limited to a contracted space, whose distance from Greenwich changes in a very sensible proportion from summer to winter, and may well be supposed to be a limited space over which the sun is nearly vertical; (4) that the action while the sun passes over Africa is much less than that which follows it,—we seem to be led to the following conclusions:—

"The radiation of the sun upon the sea produces a magnetic force, which attracts the north end of the magnet at Greenwich.

"The radiation of the sun upon the land produces an insensible force, or none at all.

"The great cause of diurnal inequality at Greenwich is the radiation of the sun upon the North Atlantic; the radiation upon other seas having a sensible but minor effect.

"I am unable to explain the origin of the singular 'feature in the diagram' from VII^h to XV^h Göttingen time, but suppose it to arise from some peculiarity in the distribution of land in the great islands of the Pacific, Australia, &c.

"Now as we know that the attractions of magnetic bodies diminish very rapidly with their distance, and therefore the effect of the seas illuminated from 7^h to 17^h is very small . . . . . . and then we have due preponderance given to the intense disturbing force from 22^h to 4^h Greenwich time. The mean declination of the magnets therefore will contain in its numerical expression a westerly quantity derived from that preponderance, and the mean horizontal force will contain in its numerical expression a diminution of force similarly derived.

"And in those months of the year when the active space under the sun comes nearest, this westerly quantity and this diminution of force will be exaggerated; and therefore the mean westerly declination (after correction for secular change) will appear greatest, and the horizontal force will appear least in the summer months.

"I present this sketch of the foundation of a theory of diurnal inequality as one of which I have no doubt, as applying to Greenwich. I am unable yet to examine into the practicability of extending it to other stations."

In referring to the vertical force magnetometer, he remarks:—

"In the progress of years, from 1848 to 1857, the diurnal inequality in both the horizontal elements is greatly diminished; while that in the vertical direction increases greatly from 1849 to 1850, and is sensibly stationary from 1850 to 1857 ...... This seems to show that it is not the same quality of the sun which produces the horizontal disturbance and the vertical disturbance ...... The epochs of maximum and minimum of vertical force seem to refer very distinctly to noon at Greenwich, while those of the horizontal forces refer to other hours. The monthly changes of inequalities generally correspond; the westerly declination, the southerly horizontal force, and the downward vertical force increasing in the hotter months."

In reference to the moon's action:—"It may be explained by one of the following suppositions:—

"(1) The earth is a great magnet, with virtual poles in a definite position with respect to the earth; and the moon becomes magnetic by instantaneous induction.

"Or (2) the moon produces in the terrestrial atmosphere a tide, by the ordinary mechanical laws of formation of tides, and the compression and expansion of the oxygen or other magnetic portion of the atmosphere produce these alternate magnetic effects; no explanation, however, being yet suggested of the peculiar direction of the force" ......

"With regard to the action of the moon, it is conceivable that the moon is, under the action of the sun, a magnet whose axis is directed to the sun."—1861, April 10.

[A complete set of the Greenwich Magnetic and Meteorological Observations, from 1840 to this the last volume issued, have been presented to the Society, and are placed in the Library.]

INSTRUMENTS.

1. *Description of Mr. L. M. Casella's Mercurial Minimum Thermometer.*

The object of this instrument is to enable meteorologists to employ mercury in the registration of cold, as they have heretofore done in the registration of heat, and without having recourse to bulky instruments. Present temperature is shown, and past cold registered by this instrument. At each indication the mercury returns to its normal state, no portion being separated to form an index; neither are detached or foreign indices employed.

The thermometer, which is of an ordinary size, is shown in fig. 1. It has a small glass branch-tube attached near the bulb, which is shown on a larger scale in fig. 2. The internal arrangement of

this supplementary or branch tube is a pyriform chamber (*a*), with a diaphragm at *b*, having a small aperture intervening between the chamber and the rest of the branch. The stem is graduated, when all the lower part of the instrument, except the little chamber *a*, is full of mercury.

Fig. 2.

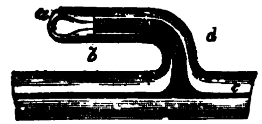
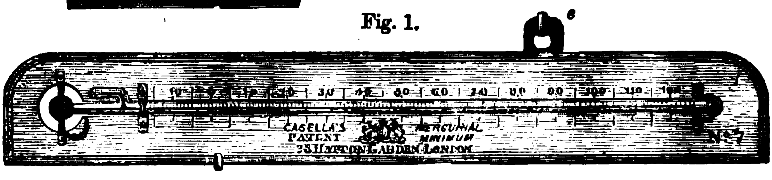


Fig. 1.



When this instrument is properly set, it shows the temperature of the place at the time of setting. If the temperature then *rises*, the bulk of mercury expands as usual; but the resistance offered at the aperture *b* is less than that presented by the capillary bore of the long tube; and therefore the column in the stem remains stationary, the increased bulk of mercury passing through the small aperture into the pyriform cavity *a*; and the minimum temperature is retained.

When the temperature *falls* after the instrument has been set, the mercury of course contracts; but there is a greater amount of adhesion at the larger surface at *b*, than in the capillary bore. The mercury remains stationary in the limb *d*, and as the contraction continues, it recedes along the stem; and the minimum temperature is registered for the reason (given above) that any subsequent expansion sends the mercury into the cell in chamber *a*, and not along the capillary bore.

To set the instrument, place it in a horizontal position, with the back plate (*e*) suspended on a nail, and the lower part supported on a hook (*f*). The bulb end may now be gently raised or lowered, causing the mercury to flow until the bent part (*d*) is full and the chamber (*a b*) quite empty; at this point the flow of mercury in the bore of the tube is suddenly arrested, and indicates the exact temperature of the bulb or air at the time. On an increase of temperature the mercury will expand (as above explained) into the small chamber (*a b*); whilst a return of cold will cause its recession from this chamber only, until it reaches the diaphragm (*b*). Any further diminution of heat withdraws the mercury down the bore to whatever degree the cold may attain, where it remains until further withdrawn by increased cold, or till re-set for future observation.

By this means, cold may be registered to any fraction of a degree observable on the most delicate standard thermometer.

No vicissitudes of climate or transit can in any way disarrange the instrument.

Whatever temperature the instrument may indicate when set, or may recede to afterwards, or may rise to after this, it must resume the same conditions at every return to a similar degree of cold; that is to say, whatever degree of cold it may indicate *at any* observation, its condition, and consequently its *precision, must always be precisely the same* on every return to the same degree; and this whatever heat may have intervened.

Again, when, after being set, any mercury is observed in the small chamber, the column only represents the extreme of cold that has been registered. On causing this to flow out of the chamber, present temperature will be shown; but of course this indication cannot be obtained while any mercury is within the chamber (a b).

L. M. CASELLA, Jun.

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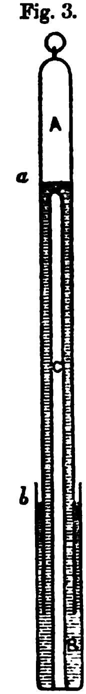
2. *Description of Mr. R. Howson's New Barometer.*

THE object of this instrument (which was exhibited at the Meeting) is to add to the sensitiveness of the ordinary mercurial column, by giving it an increased range, a desideratum which it appears to accomplish with simplicity and efficiency.

Fig. 3.



The principle of construction will be understood on reference to the diagram (fig. 3), which represents a section of the working parts of the barometer divested of its case and all other external arrangements requisite to render the instrument complete.

A is the barometer tube, which is of large diameter, and of greater length than usual in proportion to the additional length of range which it is intended to apply to it. The cistern B is of a tubular shape, so as to contain a fixed depth of mercury, also determinable by the range. To the bottom of this cistern is attached, concentrically, a light stalk or long hollow tube, hermetically sealed, springing to a height of about 28 inches above the fixed level of the mercury in the cistern.

When all the parts are *in situ*, as in the diagram, the tube A being freely suspended, and the whole filled with the requisite quantity of mercury, the immediate result of the arrangement is that the cistern hangs in suspension without the necessity of any fixed support. The stalk C, it will be observed, passes axially up the tube A, and terminates a little below the upper level of the mercury a: its upper end is therefore exposed to no more downward pressure than that caused by the weight of the mercury above it, and consequently there is an excess of upward pressure from the atmosphere exteriorly which tends to raise the cistern.

If we suppose, for instance, the area of the stalk to be

half a square inch, and its top to be covered with 1 inch in depth of mercury (the space above being of course a vacuum), there will be a pressure tending to push the cistern downwards of only $\frac{1}{4}$ lb. or thereabouts, while the atmosphere will be pressing upwards on an equal area with a force of 7 lbs. or more. Thus it will be seen that when the excess of upward pressure is exactly balanced by the weight of the cistern with its stalk, and contained mercury up to the level *b*, an equilibrium will be established which will keep the cistern stationary. If from any cause the cistern should become lighter, it will ascend; if it should become heavier, it will descend, and the extent to which it will move in either case will be limited by the immersion or emersion of the tube A, or rather of the glass which bounds it. This is precisely the action which takes place under the influence of the fluctuations of atmospheric pressure. For, let the internal area of the tube A be supposed to be 1 square inch, and let a barometric rise take place equal to 1 inch by the ordinary standard, it is evident that a cubic inch of mercury will under these conditions leave the cistern, pass into the tube, and accumulate above the top of the stalk: consequently the cistern, being relieved of a portion of its weight, will be pushed upwards until the cubic inch is replaced by the immersion of the glass of the tube A. As soon as this point has been reached, it will become stationary; but in the mean time, in the act of rising, it will have pushed up the entire column before it; so that the total rise of the top of the column will be compounded of two motions, viz. of the ordinary barometric rise, and the rise of the cistern. The converse of this of course takes place on the occurrence of a fall of atmospheric pressure. When the column moves, the cistern follows it in all cases; and when the cistern moves, it drags the entire column with it.

Perhaps the most simple way of regarding the mode of action is to suppose the tube A to be a cylinder, with a long piston (or plunger) fitted into it, the stalk being the piston, and the surrounding mercury a mobile packing or seal. Above the piston is a vacuum, and below it a self-graduating weight which balances the upward pressure of the air. If now we imagine the thickness of the glass of the tube to be =0, it is evident that the piston, if it once commenced to ascend through excess of atmospheric pressure, however small that might be, would continue to do so to an indefinite extent, because there would be nothing to stop it. The glass, however, has in reality more or less substance, displacing in all cases a quantity of mercury corresponding to the depth of its immersion in the cistern. It will therefore present a resistance to the ascent of the cistern, and the latter will come to rest at that point where the additional displacement becomes equal to the increment of pressure. It will thus be perceived that the extent of range which this instrument acquires over and above that of the ordinary Torricellian column is dependent upon the ratio which the internal area of the tube A bears to the annulus of glass which bounds it.

Let T = the internal area of the tube.
G = the area of the ring of glass.
P = any given increment of pressure in inches of mercury = any given rise of the common scale.

To find R = the corresponding rise of the new or increased scale.

The force tending to make the piston ascend is measured by T, while the force tending to limit the ascent is measured by G.

∴ The rise of the piston due to the variation P will be expressed by $\frac{TP}{G}$. In addition to this, however, the column itself or "packing" will have risen above the top of the stalk to the extent of P; so that the total rise as indicated on the scale will be expressed by the formula $R=\frac{TP}{G}+P$. It is easy to see from this that when $T=G$ the range will be doubled, and when T is largely in excess of G, the range will be correspondingly increased.

In the construction of this instrument, it may be mentioned that some difficulty occurred in the first instance in rendering it portable, and in filling it in such a manner as to secure the perfect absence of air above the column. These questions necessarily involved a variety of experiments, which it is not necessary to detail, the result being entirely successful. An efficient degree of portability is obtained by an arrangement which prevents the entrance of air into the tube under any circumstances, while the filling is effected with the assistance of an air-pump in such a way as to ensure a clear column and a perfect vacuum.

The instrument was stated to have been in constant use for upwards of six months, and its motions have been found to follow with accuracy those of the best standard barometers*. Owing, however, to its greatly increased range, as may readily be supposed, much advantage is gained in the facility of observing small fluctuations. Its sensitiveness and activity during storms is especially conspicuous, and it is not unreasonable to expect, in reference to this property, that it will supply a want in certain classes of scientific observation†; while for domestic purposes as an ordinary weather-glass, or for public use among our seafaring population, its value is sufficiently obvious. It gives its replies in characters so unmistakeable that the most unobservant may read them.

R. Howson.

* Mr. Glaisher states that he had this instrument in his possession for a couple of days, and that during this time its changes were nearly accordant with those of a standard barometer.

† In reference to observations of an accurate character, it ought to be stated that the construction confers the incidental advantage that the cistern is self-adjusting with regard to its level. Readings may be taken to three places of decimals without a vernier, and without any adjustment for variation of level in the cistern. At the same time the error due to temperature is of an almost inappreciable amount.

3. *Description of Negretti and Zambra's Pocket Barometer.*

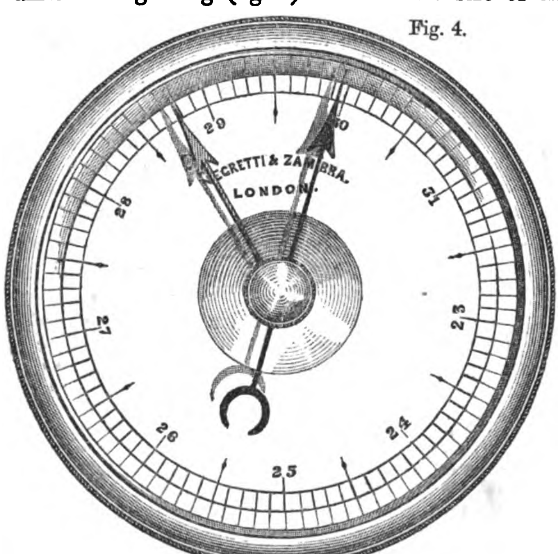
Messrs. Negretti and Zambra have just introduced to the notice of meteorologists and the public generally, a small and exact aneroid. It is 2·75 inches in diameter, and 1·6 inch thick; it weighs 11¾ oz.; it is truly a pocket instrument, and will be welcome to travellers, who have long been asking for the dimensions of the ordinary aneroid to be reduced.

Messrs. Negretti and Zambra do not take credit to themselves for inventing this instrument, but for bringing it forward as a diminutive aneroid barometer, and one which can be depended upon for as great accuracy as that of which any metallic barometer is capable.

The construction of a small aneroid barometer of sufficient accuracy, yet diminutive enough to be carried in the pocket, has hitherto been deemed impossible; many trials have been made, which resulted in as many failures. The great difficulty consisted in constructing a vacuum-chamber sufficiently small, yet sufficiently elastic to expand and to be depressed according to the variations of the atmospheric pressure. The increase or decrease of the bulb of the vacuum-chamber is the mechanical means by which the barometrical indications are obtained. In the instrument now under notice, the difficulties in question seem to have been overcome, and the smallest barometer yet constructed has now been produced.

The annexed engraving (fig. 4) is the exact size of the baro-

Fig. 4.



meter. This is considered to be a great step in the right direction. Messrs. Negretti and Zambra, and their workmen, have bestowed great care in the construction of the instrument.

Negretti and Zambra.

Observations in Meteorology; relating to Temperature, the Winds, Atmospheric Pressure, the Aqueous Phenomena of the Atmosphere, Weather Changes, &c. By the Rev. LEONARD JENYNS, M.A., F.L.S., &c. Post 8vo, 10*s*. 6*d*.

JOHN VAN VOORST, 1 Paternoster Row.

Practical Meteorology. By JOHN DREW, Ph.D., F.R.A.S., Corresponding Member of the Philosophical Institute of Bâle. Second Edition, foolscap 8vo, with 11 Illustrative Plates, 5*s*.

JOHN VAN VOORST, 1 Paternoster Row.

On the 1st of March will be published, in 8vo, price 1*s*.

British Rain-fall.—Tables showing the total depth of rain at more than 400 places in England, Scotland, and Ireland, for the years 1860 and 1861. Compiled from the observers' own reports. By G. J. SYMONS, Member of the British and Scottish Meteorological Societies, &c.

London: EDWARD STANFORD, 6 Charing Cross.

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Second Edition. Price 2*s*. 6*d*.

Glaisher's Hygrometrical Tables.—Hygrometrical Tables to be used with, and Description of the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

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Glaisher's Tables for Reducing Observations of Barometers with Brass Scales—extending from the cistern to the top of the Mercurial Column—to the Temperature 32° Fahrenheit, for all readings between 27 inches and 31 inches, and for every degree of Temperature from 1° to 100° Fahrenheit.

TAYLOR and FRANCIS, Red Lion Court, Fleet Street, London.

[*Price Two Shillings.*]

Vol. I.] [No. 2.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

1862, JANUARY 15.

CONTENTS.

LONDON:

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NOTICE TO MEMBERS.

THE Council desire to issue 'THE PROCEEDINGS OF THE BRITISH METEOROLOGICAL SOCIETY' four times during the year; and to issue each Number as soon as possible after the Ordinary Meeting to which it refers.

One copy of each Number will be forwarded *free* to each Member of the Society.

The 'Proceedings' will be published by Messrs. Taylor and Francis; and each Number will show the price at which it will be sold to the public; and which will also be made known, together with the day of publication, by public advertisement.

The "Publication Committee" request the co-operation of Members, in communicating information, and in promoting the establishment of the 'Proceedings' on a permanent basis.

No. 3 of the 'Proceedings,' being the Report of the Meeting in March 1862, &c., is in the press, and will shortly be in the hands of Members.

*** The Report for the year ending 1861, June 12, is in hand. Each Member will receive his copy as usual, when it is ready.

Members are informed that, at the Annual General Meeting held 1861, June 12, certain alterations were made in the "Institutes" of the Society.

1. The Admission Fee of £1 is abolished; the Annual Contribution remaining £1 as heretofore.
2. The Composition Fee is made £10 instead of £12.
3. Council Meetings are reckoned as Ordinary Meetings for promoting the election of Members, except that the Election itself must take place at an Ordinary Meeting.

[*Advertisements continued on the third page.*

BRITISH METEOROLOGICAL SOCIETY.

THIS Society was established in the year 1850, for the encouragement and promotion of Meteorological Science.

It consists of Members and Honorary Members.

Every person desirous of admission into the Society must be recommended by at least Three Members, of whom one must certify to his personal knowledge of such Candidate.

Candidates may be proposed at a Council Meeting; but the ballot must take place at an Ordinary Meeting. One Council or Ordinary Meeting must intervene between the nomination and the day of Election.

There is no Admission Fee. The Annual Contribution is £1; due on January 1. The Composition Fee is £10.

Persons eminent in Meteorological Science, not permanently residing in this country, are eligible as Honorary Members.

The Council of the Institution of Civil Engineers allow the Society to hold their Meetings at the Institution, No. 25 Great George Street, Westminster, S.W.; and to receive letters there.

Four Ordinary Meetings are held during the Session, which commences in October and terminates in June, at which Members can introduce their friends.

Papers accepted for reading at the Ordinary Meetings are published entire or in Abstract in the 'Proceedings' of the Society, which are issued as soon as possible after each Meeting, *and of which a copy is sent to every Member of the Society.* The 'Proceedings' also contain Notices of Books and Memoirs, descriptions of New Instruments, and other Meteorological News.

Daily observations are made, for the most part by Members of the Society, at about 60 different stations, which are forwarded monthly to one of the Secretaries, by whom each reading is examined and collated with readings made in adjacent stations. Their means are taken; and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of each 'Quarterly Meteorological Report' *is sent free to every Member of the Society.*

Copies of printed results of Meteorological Observations or Papers are from time to time received by the Society for distribution; and *are forwarded free to Members.*

The 'Proceedings' of the Society are published and sold by Taylor and Francis, Red Lion Court, Fleet Street, E.C.

The Society possess a Library, which is available to Members. The President, N. Beardmore, Esq., has kindly received it in his rooms, 30 Great George Street.

1862, March 1.

JAMES GLAISHER, F.R.S.,
Dartmouth Place, Blackheath, S.E.
CHARLES V. WALKER, F.R.S.,
Fernside, Redhill.
} *Secretaries.*

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. I.] 1862, JANUARY 15. [No. 2.

N. BEARDMORE, Esq., C.E., F.R.A.S., President, in the Chair.

Louis P. Casella, Esq., F.R.A.S., F.R.G.S., South Grove, Highgate;
J. Sladen, Esq., Royal Artillery, Fort Victoria, Yarmouth, Isle of Wight;
The Honourable Samuel Cockburn, Governor of the Island of Montserrat;
were balloted for and duly elected Members of the Society.

VIII. *On the Pressure of the Wind in Strong Winds and in Gales, at the Royal Observatory, Greenwich, from the year* 1841 *to* 1860. By JAMES GLAISHER, Esq., F.R.S., Secretary to the British Meteorological Society.

AT the last Meeting of the Society, I had the honour to read a paper upon the "Direction of the Wind at the Royal Observatory, Greenwich, during the 20 years ending 1860." In the present paper I propose to speak briefly of every high wind and gale, which has taken place at Greenwich, during the same series of years, excluding all light winds, or those in which the pressure upon a square foot of surface has been less than 5 lbs., and to determine the relative frequency of high winds and gales, with different directions of the wind and in different months of the year, from estimation in January 1841, and as deduced from the

self-registering records from Osler's anemometer, from February 1841 to December 1860. I shall first proceed to speak briefly of each successive high wind.

Pressure of the Wind in every High Wind and Gale, from Osler's Anemometer.

1841.—From February 5 to 8 the wind blew from E.N.E., with an almost constant pressure of 3 to 5 lbs., occasionally to 10 lbs., and once to 14 lbs., on the square foot. On March 5 there was a strong wind to 9 lbs.; again in September and October to 7 lbs. From November 28 to 30 the wind was from S.S.W., with pressure of 5 lbs., increasing at times to 6 and 10 lbs., and occasionally to 16 lbs., and once to 24 lbs., which was the heaviest recorded pressure in the year.

1842.—On January 26, in a gale from S.W., a pressure of 18 lbs. was recorded. Another gale took place on March 2 and 3, with occasional pressures to 17 lbs. On March 9, partly from the W.S.W. and S.W., and afterwards from W.N.W., there was a gale of wind in which a pressure of 21 lbs. took place, being the greatest in the year. A strong wind blew on March 30 from the S.W., and a gale on March 31 from the same quarter, and again on May 6 and 7, at both of which times pressures of 13 lbs. took place; and on September 8 pressures of 10 and 12 lbs. were recorded. No great pressures occurred after this, till the end of the year.

1843.—On January 9 and 10 there were pressures varying from 7 to 10 lbs., and once to 14 lbs. A gale of more than usual violence took place on January 12, 13, and 14; in this gale the direction was W.S.W., and the pressure, 25 lbs., was the greatest in the year. On February 4, the wind blowing from the N., a pressure of 21 lbs. was recorded. On February 17, 18, and 19, pressures to 7 lbs. took place. During a steady E.N.E. wind, on March 25 and 26, there were pressures from 3 to 9 lbs. On April 1 and 2 a strong wind blew from the S.W. and W.S.W., during which a pressure of 10 lbs. was recorded. On April 4 pressures of 12 and 13 lbs. took place, from the W.S.W.; and on April 8, a pressure of 7 lbs., with the same direction. A strong wind blew from the S.W. on June 7, 8, and 9, recording pressures varying from 3 to 7 lbs. On October 6, 7, and 11 a strong S.W. wind blew, recording pressures to 8 lbs.; and on Nov. 19, 20, and 21, in a gale from S.S.W., pressures of 10 and 12 lbs. took place.

1844.—On January 19, pressures of 5 lbs. were recorded. On January 30 and 31 a gale blew from the N.W., recording pressures

of 12 lbs. On February 23 a strong wind from the S. and S.W., with 12 lbs. On February 25 and 26 the wind blew strongly, the direction varying from S.W. to N., during which pressures of from 3 to 7 lbs. were recorded; and a strong wind from the S.W. took place on March 1, 2, and 3, in which several of 6 and 8 lbs., and one of 9 lbs., were recorded. On March 10, 11, and 12 the strongest gale of the year prevailed, the direction of wind being S.W. and W., generally, on the 10th and 11th and during a good part of the 12th, and nearly N. and N.W. during the remainder of the 12th; in this gale a pressure of 17 lbs. was recorded on March 12. On March 16 and 17 a strong wind blew from the E. and N.E., registering pressures of from 5 to 7 lbs.; and again on May 19 and 20 from the N.N.E. and N., registering pressures of from 5 to 7 lbs., and once to 9 lbs. On June 7 the wind blew strongly from the S.W., recording pressures of from 6 to 8 lbs. On July 1, at 6^h, a sudden gust of 9 lbs. is recorded. On July 13 and 14, pressures from 5 to 7 lbs., and once to 10 lbs., with S.W. wind. On August 3 a strong S.W. wind registered pressures of from 3 to 9 lbs.; and again on October 1, pressures of from 6 to 8 lbs. were recorded, with the same direction; and on November 1, pressures of from 4 to 7 lbs., with an E. wind.

1845.—On January 10 and 11, pressures from 3 to 6 lbs. were recorded. Gales of wind blew on January 19 and 20, from the N., and on the 26th from the S.W., registering pressures of from 10 to 13 lbs.; this was the highest pressure recorded during the year. On March 15 the wind blew strongly; pressures from 3 to 7 lbs. were recorded, the direction varying from N.E. to E.N.E. On March 28, pressures of 9 and 10 lbs., with a W.S.W. wind. On April 14 and 15 the wind blew strongly, on the 14th from the W.N.W. and N.N.W., and on the 15th from the N.N.E.; during these gales pressures of from 10 to 12 lbs. were registered. Again, on April 25 and 26, with a S.S.W. wind, pressures of from 5 to 7 lbs.; on May 21 from 2 to 10 lbs., with a N. and N.N.E wind; and on July 1 from 3 to 9 lbs., with a W.S.W. direction. At 1^h, on August 9, a pressure of 7½ lbs. took place. On August 19 and 20, a strong wind blowing from the W.S.W., pressures of 6 and 7 lbs. were registered; and on September 18, pressures of 8 and 9 lbs., with a S.S.W. direction.

From the preceding account it will be seen that no great gale occurred through the whole year, and that the strong winds, with a few slight exceptions, were from the S.W. or W.S.W.

1846.—The first strong wind during this year blew from January

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19 to 22, with principally a S.S.W. direction; frequent pressures from 3 to 10 lbs. were recorded, and one of 12 lbs., being the greatest registered during the year. From January 29 to 31 the wind blew strongly from the W.S.W., and pressures from 4 to 7 lbs. were recorded; and again on February 6 and 7, with a W.S.W. wind, pressures from 4 to 7 lbs. On March 16, with a wind from the S.W., pressures of from 7 to 11 lbs. On April 3 and 4, with a W.S.W. wind, pressures of 5 to 11 lbs. On July 18 the wind blew strongly from the S.W., recording pressures of 5 to 9 lbs. On October 8, 9, and 10, pressures of from 3 to 8 lbs., direction of wind varying from S. to W. On October 13, the wind blowing from the N.N.W., pressures of 3 to 5 lbs.; and again from the 20th to the 23rd of the same month, pressures of 1 to 8 lbs. were registered, direction passing between S. and S.W. On November 22, at 2^h 20^m, a sudden gust recorded 11 lbs. during a squall.

1847.—On January 27 and 28 the first strong wind of the year blew from the S.S.W.; during this wind pressures of from 3 to 12 lbs. were recorded. On February 19 a gale blew from the W.S.W., and during its prevalence pressures of from 12 to 18 lbs. were recorded; this was the greatest pressure recorded during the year. On April 8, with the same direction (W.S.W.), pressures from 4 to 15 lbs. April 26 to 28, wind from the S.W. and W.S.W., pressures from 3 to 8 lbs. From the S.S.W. the wind blew strongly for some hours on the 8th of May; maximum recorded pressure of 8 lbs. From September 16 to 18, the wind blowing from the W.S.W., pressures of from 4 to 12 lbs; on October 23, from the S., pressures to 8 lbs.; and again on November 23, from the S.S.W., pressures of 5 lbs. were recorded. On December 6 and 7 a gale blew from the S. and S.W., recording pressures of from 7 to 13 lbs.

1848.—On January 17, the wind blowing from the S.S.W., pressures to 6 lbs. were registered. On January 26 and 27, pressures up to 6 lbs., with a N.E. wind. On February 9 a gale blew from the S.S.W., recording a pressure of 13 lbs., which was one of the greatest recorded during the year, the same pressure being recorded during a gale on June 13. On May 10 and 11 a strong S.W. wind blew, registering pressures of from 5 to 8 lbs. On April 12, 5 lbs. pressure was recorded under a S.W. wind; and again on May 18 and 19, with the same direction, pressures of from 2 to 6 lbs. On June 13 a gale blew from the S.W., during which a pressure of 13 lbs. was recorded; and on the 29th of the

same month, with a wind from the same direction (S.W.), a pressure of 12 lbs. Pressures of from 3 to 8 lbs. were registered, with a S.W. wind, on July 7 and 8; and again on July 20 and 21, pressures of from 6 to 9 lbs. with a S.W. wind. On August 21, with a wind from the S.S.W., a pressure of 9 lbs. On October 25, a strong wind blowing from the S.S.W., pressures of from 4 to 10 lbs.; again on October 28, the wind blowing from the S., a pressure of 8 lbs. was recorded. On November 20 a pressure of 9 lbs., with a southerly wind; on November 30 a pressure of 7 lbs., with a S.W. wind; and again on December 4 a pressure of 12 lbs., with a S.W. wind.

1849.—On January 10 and 11 the wind blew from the W., registering pressures of 4 to 10 lbs.; on January 14, from the S.S.W., pressures up to 15 lbs.; and again on January 24, from the W.S.W., pressures of from 3 to 10 lbs. On February 22 a pressure of 10 lbs. was recorded, with a W.S.W. wind; and again, on the 28th of the same month a pressure of 22 lbs., with a S.W. direction; this was the greatest pressure recorded during the year. On March 1 and 7, strong S.W. winds blew, and on both days pressures up to 8 lbs. were recorded; again, on April 18, the same pressure with a wind from the same direction (S.W.); and again on May 17, with a S.W. wind, a pressure of 12 lbs. On October 3 a gale blew, also from the S.W., and pressures of from 6 to 15 lbs. were recorded; and on December 17 a gale, also from the S.W., registered pressures of from 5 to 14 lbs.

1850.—On January 26 and 28, strong winds prevailed from the S.W., and pressures of from 3 to 7 lbs. were recorded. From February 1 to 20 a strong S.W. wind blew, almost without lull, and pressures from 3 to 5 lbs. were frequently recorded; once a pressure of 19 lbs., and once of 25 lbs., were also registered with this wind: this was the highest pressure during the year. On March 4 a wind blew strongly from the N., pressures from 5 to 6 lbs. Again on March 24, pressures of 6 lbs., with a N.N.W. wind. On the 30th of the same month, the wind blowing from the E.S.E., pressures up to 5 lbs. From April 3 to 9 a strong S.W. wind prevailed; pressures of from 6 to 15 lbs. were registered. Again, on April 16 a S.S.W. wind prevailed, registering pressures of from 3 to 9 lbs. On May 6 a N.E. wind, pressures of 5 to 6 lbs. On June 7 a S.W. wind, pressures of 5 to 6 lbs.; and again on June 13, a W.S.W. wind registered pressures of from 3 to 8 lbs. On July 7, a strong wind blowing from the N., pressures of from 3 to 6 lbs. A strong S.W. wind blowing on August 9, pressures

of from 2 to 7 lbs.; and from September 27 to 30 a strong wind from the S.W., pressures of from 2 to 5 and 6 lbs. were recorded. On October 7 a S.W. wind registered pressures up to 16 lbs; on October 11 a N.N.W. wind, a pressure of 7 lbs.; and again on November 4 a pressure of 7 lbs. was recorded, with a W.S.W. wind. From November 19 to 25 a strong S.W. wind prevailed generally, pressures from 4 to 9 lbs.; and again prevailing from December 14 to 17, pressures of from 6 to 9 lbs.

1851.—On January 1 and 2, a strong S.W. wind registered pressures of from 5 to 10 lbs. On January 16 and 17, pressures of 7 and 9 lbs., with the same direction. On January 21 and 22, pressures of 5 and 6 lbs., with a wind also from the S.W. From January 28 to 30 a strong S.W. wind prevailed, registering pressures of 5 to 7 lbs. On February 5, with a strong S. wind, pressures of 6 to 8 lbs.; and with a N. wind, on the 8th of the same month, pressure up to 5 lbs. On February 19 a S.W. wind again prevailed, registering pressures of from 3 to 6 lbs. On March 6, the wind blowing from the N., pressures of 5 to 7 lbs. were noted. A strong S.W. wind prevailed generally between March 22 and 29, pressures from 5 to 10 lbs. On April 4, with a N.E. wind, a pressure of 5 lbs. was recorded; and on April 26 a pressure of 6 lbs., with a wind blowing from the N. and S.W. On May 19 pressures of from 3 to 8 lbs., with a W.S.W. wind; and from June 5 to 16 a S.W. wind prevailed, at times blowing with some strength, with which pressures of from 5 to 8 lbs. were registered. On August 24 the greatest pressure of the year was recorded, one of 11 lbs., from the S.S.W. On November 21 and 22 pressures of 5 and 6 lbs., with a wind blowing from the N.; and on December 21 pressures up to 9 lbs., with a wind from the S.S.W.

1852.—On January 3 and 4 a strong wind blew from the S.W., registering pressures up to 10 lbs. On January 9, a W. wind prevailing, pressures of from 7 to 13 lbs. were recorded. January 15, pressures up to 16 lbs., with a wind from the W.S.W. January 16 a pressure of 12 lbs., with a S.W. wind; and again on January 22, pressures up to 10 lbs., with a wind from the S.S.W. On February 4 and 5 a strong wind blowing from the W.S.W., pressures of from 6 to 10 lbs. On April 24, with an easterly wind, pressures of 7 to 9 lbs. On May 11 a strong wind blowing again from the S.W., pressures to 10 lbs. On June 16 a wind blowing from the S.S.E., registering a pressure of 7 lbs.; on August 11 from the S., pressures of from 8 to 16 lbs.; and again on September 21 and 29,

from the W., pressures of 5 to 7 lbs. were recorded. On September 30 from the S.S.W., maximum pressure recorded 6 lbs. On October 4 and 5, pressures of 9 and 10 lbs., with a S.W. wind. November 6 and 7, pressures of 7 to 12 lbs. with the same direction (S.W.); and again on November 12 and 13, pressures of 7 to 10 lbs., with a N.E. and E. wind. A strong wind blew from the S. on the 25th and 26th of the same month, registering pressures of from 7 to 10 lbs. A S.W. wind blew generally throughout the month of December, at times with great strength; frequent pressures of from 5 to 9 lbs. were recorded; occasionally the pressure was as high as 12 and 15 lbs., and once to 24 lbs. on the 27th of the month, this being the greatest pressure recorded during the year.

1853.—On January 4 and 6 a strong S. wind blew, recording pressures up to 7 and 12 lbs. respectively. On January 11 and 12 the wind blew strongly from the S.W., as also on January 15; on each of these days pressures up to 8 and 9 lbs. were recorded. On January 22 and 23 the wind blew strongly from the N.W. and N., pressures up to 5 lbs. registered. On February 17 a 5 lbs. pressure, with a N. wind. From February 23 to 27 a continual pressure was registered of from 5 to 10 lbs., and once to 15 lbs. on the 26th, which was the greatest recorded during the year; during this gale the direction of wind was principally N.W., varying however between that point and N.N.E. On March 2 a pressure of 6 lbs. with a N.W. wind. On April 1, 2, and 3, a S.W. wind prevailing, pressures from 5 to 8 lbs. On April 7, 8, and 10, wind blowing from the N.W., pressures of from 5 to 8 lbs.; and on the 13th of the same month a pressure of 6 lbs. was registered with a N.E. wind. On May 8 and 10, pressures of 5 lbs. with a N.W. wind. On May 14, the wind blowing from the E.S.E., pressures of 6 lbs. On May 22 from the N.E., and on May 31 from the N., pressures of 5 lbs. On June 24 a pressure of 5 lbs. with a S.W. wind; and, the wind still blowing from the same direction on June 27, 28, and 29, pressures of from 5 to 12 lbs. were recorded. On July 16, 26, and 30, pressures of 5 and 6 lbs. with a S.W. wind. August 26, the wind blowing from the S., pressures of from 6 to 11 lbs. On August 27, the wind again blowing from the S.W., pressures up to 9 lbs. September 24, the wind blowing from the W.S.W., a pressure of 5 lbs. September 25, blowing from the S.W., pressures of from 7 to 13 lbs., and September 26 from the W.N.W., a pressure of 9 lbs., were recorded. Again, on September 28 and 29 a S.W. wind prevailed, registering pres-

sures of 5 and 6 lbs. October 1 a pressure 5 lbs. with a westerly wind. October 17 a pressure of 6 lbs. with a S.S.W. wind. October 21 and 22, the wind blowing from the S.W., pressures of from 6 to 8 lbs. On the 28th of the same month, a pressure of 6 lbs. with a S. wind; and on November 8 a pressure of 5 lbs. with a wind from the N.W.

1854.—On January 3 and 4 a strong wind blew from the N.E., registering pressures of 5 and 6 lbs. From February 6 to 9, from the W.S.W., pressures of from 5 to 16 lbs. On February 17 from the S.W., pressures up to 13 lbs. On February 18, veering to the N.W., a pressure of 17 lbs., being the greatest pressure recorded during the year; and on February 19, with the same direction, a pressure of 9 lbs. On April 22 and 23 a strong wind blew from the N.E., registering pressures of from 5 to 7 lbs; and on the 27th and 28th of the same month, with a N.W. direction, pressures of from 5 to 7 lbs. On May 7 and 8, with a S.W. wind, pressures of 8 and 9 lbs.; and again on May 22, with the same direction, pressures up to 6 lbs. On September 24 a pressure of 7 lbs. was recorded, with a wind blowing from the S.W. On October 18 a pressure of 10 lbs., direction of wind being N.W.; and again on October 22, pressures up to 8 lbs. with a W. wind. On November 29 a strong wind blew from the S.W., with which pressures of from 7 to 12 lbs. were recorded; and on December 15 and 22, strong winds blowing from the W.S.W., pressures of 10 and 8 lbs. were respectively noted.

1855.—On January 1 a pressure of 18 lbs. was recorded, with a strong wind blowing from the W. On April 9 a gale began to blow from the W., pressures of 5 and 6 lbs. were registered on that day; and on the 10th a pressure of 15 lbs. was noted, being the greatest registered during the year. On April 25 a pressure of 5 lbs., with a wind from the N. On May 7, the wind blowing from the S.W., a pressure of 5 lbs.; and on May 8, the wind blowing from the N.W., a pressure of 6 lbs. was noted. On October 11 a pressure of 5 lbs. was recorded, with a W.N.W. wind. On October 25 and 26, pressures of from 10 to 14 lbs., the wind blowing from the W. and S.W.; and on October 31 a pressure of 5 lbs., with a wind from the N. On December 6 a wind blowing from the N.W. registered pressures of 7 lbs.; and again blowing from the S.W. on December 23 and 26, pressures of from 5 to 10 lbs. were recorded.

1856.—On January 24 a gale blew from the S.S.W., during the prevalence of which a pressure of 15 lbs. was recorded. On

February 6 a strong wind blew from the S., registering pressures up to 10 lbs. On February 14 a S.W. wind registered a pressure of 7 lbs.; and on February 21 a N.E. wind registered a pressure of 5 lbs. On March 13 and 14, the wind blowing from the E. and N.E., pressures of 5 and 6 lbs. were registered. From April 14 to 16 a N.E. wind prevailed, registering pressures of from 6 to 10 lbs. On May 7 and 8 a wind blowing from the N.N.E., pressures of from 8 to 10 lbs. From May 17 to 19 a gale blew from the S.W., during which, on the 18th, a pressure of 16 lbs. was recorded, being the greatest pressure of the year. On June 12 and 14 the wind again blew from the S.W., registering pressures of 7 to 10 lbs. On July 8 from the W.N.W., with a pressure of 10 lbs. On November 24, the wind also blowing from the W.N.W., pressures up to 7 lbs.; and on December 9 and 12, the wind blowing from the S.W., pressures of 9 and 11 lbs.

1857.—This year was remarkably free from gales or strong winds. On January 3 and 4 the wind blew strongly from the S.W., registering pressures of from 6 to 12 lbs.; veering to the N.E. on the 5th, a pressure of 6 lbs. was recorded. On January 20 a pressure of 7 lbs., with a S.W. wind. On March 8, the wind blowing strongly from the W., pressures up to 12 lbs.; veering to the N. on the 9th, pressures up to 7 lbs. From March 13 to 15 a gale blew from the S.W., pressures from 5 to 12 lbs. were frequently registered; and on March 14 one gust to 13 lbs., being the greatest pressure recorded during the year. On March 21 a pressure of 5 lbs. with an E.N.E. wind. Pressures to 5 lbs. on April 2 with a S. wind, and on April 13 with a wind blowing from the N.W. And on July 24, the wind blowing from the S.W., a pressure of 5 lbs. was recorded. After this date there were no pressures of any note.

1858.—On January 20, the wind blowing from the W., a pressure of 5 lbs. was recorded. On March 14 a pressure of 5 lbs., wind blowing from the N.N.W.; April 5, 5 lbs., wind blowing from the S.E. On July 25, a gale blowing from the S.W., pressures up to 15 lbs. From September 1 to 4, a gale blowing also from the S.W., pressures from 5 to 8 lbs. On September 10, the wind also blowing from the S.W., pressure of 8 lbs.; and again on the 23rd of the same month, a pressure of 9 lbs. with a S.S.W. wind. From October 3 to 13, a S.W. wind generally prevailing, pressures were registered of from 5 to 14 lbs. On October 19, the wind blowing from the E., a pressure of 9 lbs.; and on the 29th of the same month, the wind blowing from the N.N.E., a pressure of 6 lbs.

On November 6 the wind blew from the N.E., registering pressures of 5 and 6 lbs. A strong N.E. wind generally prevailed on November 14, 15, and 16, registering pressures of from 9 to 13 lbs. On November 30, a pressure of 7 lbs. was registered with a S.W. wind; veering to the W. on December 1, a pressure of 6 lbs. A S.W. wind prevailed on December 18, registering a pressure of from 6 to 10 lbs.; and again prevailing from December 21 to 27, from the same quarter, pressures from 7 to 10 lbs. were frequently recorded, once to 12 lbs. on the 22nd, and once to 16 lbs. on the 23rd, the last being the greatest pressure recorded during the year.

1859.—On January 17 and 18, the wind blowing from the S.W., a pressure of from 11 to 15 lbs. was recorded. From January 21 to 29, a gale generally prevailed from the same quarter, pressures from 8 to 18 lbs. On February 1 and 2, the wind blowing from the W., pressures of from 10 to 16 lbs. On February 4 to 5, with a S.W. wind, pressures of 8 and 9 lbs. On February 9 a pressure of 15 lbs., with a S.S.W. direction. February 11 a pressure of 8 lbs., with a S.W. wind. On February 16 and 17, pressures of 12 and 8 lbs., with S.W. and W.S.W. winds respectively. On February 26, the wind blowing from the S.W., a pressure of 10 lbs. was registered; and on the 27th of the same month a pressure of 9 lbs., with a N.W. direction. On March 8, with a westerly wind, a pressure of 12 lbs. was recorded. From March 11 to 17 a S.W. wind prevailed, at times blowing with much force; during this gale pressures of from 10 to 15 lbs. were noted. On April 2 and 9, pressures of 9 lbs., with S.W. wind. On the 10th and 14th of the same month, pressures of 7 and 8 lbs. with winds from the same quarter, veering to the N.W. on the 15th, a pressure of 13 lbs., and on the 16th from the W.N.W. a pressure of 7 lbs., were recorded. On April 27 and 28, pressures of 10 lbs., with E.N.E. and N.E. winds respectively; and on May 2 a pressure of 7 lbs. with a N.E. wind. On July 31 a pressure of 8 lbs., with a S.W. direction. On August 15 a pressure of 7 lbs., with a W.S.W. direction. On September 6 and 9, pressures of 7 and 8 lbs., with a S.W. direction; and on September 17 a pressure of 8 lbs., with a N.N.E. wind. On October 26, pressures up to 13 lbs., with a S.W. direction. On October 31 a gale commenced blowing from the S.W., which had greatly increased in violence by the 1st of November, upon which day a maximum pressure of 20 lbs. was recorded, being the greatest during the year (during this storm it was that the 'Royal Charter' was wrecked). From November 5 to 8 a gale again prevailed from the S.W., registering pressures of from 11 to

17 lbs. From December 4 to 7 another gale prevailed from the S.W., registering pressures of from 6 to 12 lbs. On December 14 and 15, the wind blowing from the N., pressures of 5 to 7 lbs.; and on the 20th and 21st of the same month, the wind again blowing from the S.W., pressures of 10 and 11 lbs. were registered. Again, from December 28 to 31, the wind also blowing from the S.W., pressures of from 8 to 11 lbs. were registered.

1860.—From January 1 to 4 a strong wind blew from the S.W. quarter, and pressures of from 7 to 12 lbs. were registered. From January 20 to 30, the wind again blowing from the same quarter, pressures of from 6 to 17 lbs.; veering to the N. on the 31st, a pressure of 7 lbs. was recorded. On February 2, the wind blowing from the N., a pressure of 8 lbs. On February 5, with a S.W. wind, a pressure of 7 lbs.; veering to the N.W. on the 6th, pressures up to 12 lbs. On February 7 and 8, the wind blowing again from the S.W., pressures of from 6 to 10 lbs. were noted; veering to the N.N.E. on the 9th, a pressure of 8 lbs. was registered. On February 11 a pressure of 7 lbs., with a S.E. direction. On February 13 and 14, with a N.E. wind, pressures of from 5 to 11 lbs.; and on February 16 and 17, with a N.E. direction, pressures of 7 and 8 lbs. On February 19 and 20 the wind blew strongly from the N.W., registering pressures of from 7 to 17 lbs. On February 27 and 28 a gale blew from the W., W.N.W., and W.S.W., during the prevalence of which, pressures of from 21 to 28 lbs. were recorded; this was the greatest pressure recorded during the twenty years under discussion, and took place when the wind was blowing from the W. The details of this gale are as follows:—

	d.	h.		d.	h.		
From	26	22	to	27	10	the direction of the wind was	W.N.W.
„	27	10	to	27	22	„ „ „	W. and S.W.
„	27	22	to	28	0¼	„ „ „	W.S.W.
„	28	0¼	to	28	1¾	„ „ „	W.
„	28	1¾	to	28	5¼	„ „ „	W.N.W.
„	28	5¼	to	28	9	„ „ „	W.
„	28	9	to	28	22	„ „ „	W. and W.S.W.

And

	d.	h.		d.	h.		
From	26	22	to	27	0	the pressure of the wind was	7 to 12 lbs.
„	27	0	to	27	1	„ „ „	8 to 12 lbs.
„	27	1.0	to	27	1.35	„ „ „	8 to 21 lbs.
„	27	1.35	to	27	1.55	„ „ „	7 to 9 lbs.
„	27	1.55	to	27	2	„ „ „	7 to 17 lbs.
„	27	2	to	27	3	„ „ „	8 to 17 lbs.
„	27	3	to	27	22	„ „ „	4 to 19 lbs.
„	27	22	to	27	23	„ „ „	7 to 14 lbs.

	d.	h.		d.	h.				
From	27	23	to	27	23.15	the pressure	of the wind	was	14 to 19¼ lbs.
„	27	23.15	to	27	23.30	„	„	„	14 to 25 lbs.
„	27	23.30	to	28	0	„	„	„	15 to 22 lbs.
„	28	0	to	28	0.40	„	„	„	17 to 22 lbs.
„	28	0.40	to	28	1	„	„	„	18 to 28 lbs.
„	28	1	to	28	1.35	„	„	„	17 to 20 lbs.
„	28	1.35	to	28	1.45	„	„	„	17 to 25 lbs.
„	28	1.45	to	28	2.20	„	„	„	11 to 16 lbs.
„	28	2.20	to	28	3	„	„	„	11 to 26 lbs.
„	28	3	to	28	4	„	„	„	8 to 19 lbs.
„	28	4	to	28	4·20	„	„	„	4 to 7 lbs.
„	28	4.20	to	28	9	„	„	„	3 to 8 lbs.
„	28	9	to	28	16	„	„	„	2 to 4 lbs.
After	28	16 no pressure.							

The varying pressures here shown may be taken as the ordinary course of a gale of wind.

On March 4, the wind blowing from the W., a pressure of 8 lbs. was recorded. On March 7 and 8, pressures of 8 and 10 lbs., with a N.E. wind. On the 20th and 21st of the same month, the wind blowing from the S.W., pressures of from 10 to 16 lbs. From March 23 to 31, pressures of from 5 to 16 lbs., the direction of wind varying from S.W. to N.W. On April 1, 2, and 3, pressures of from 5 to 11 lbs., with a S.W. wind. On April 5, the wind blowing from the N.E., a pressure of 7 lbs. On April 8 a pressure of 8 lbs. was recorded, with a S.W. direction; veering to the N.W. on the 9th, a pressure of 9 lbs. was recorded. On the 18th and 19th of the same month, pressures of 11 and 12 lbs. were registered, with a N.E. direction; and on April 25, the wind also blowing from the N.E., a pressure of 7 lbs. On May 1 and 2, the wind blowing from the E.N.E., a pressure of from 5 to 8 lbs. From May 26 to 29, the wind blowing from the W., pressures of from 5 to 23 lbs. Throughout the month of June a strong S.W. wind prevailed; on the 2nd and 3rd, pressures of 23 and 15 lbs. were recorded; on other days the pressure varied from 5 to 8 lbs. Throughout the month of August a strong S.W. wind prevailed, pressures of from 5 to 9 lbs. being registered. On October 5 a pressure of 8 lbs. was registered, with a S.W. wind. On October 9 and 10, the wind blowing from the W.N.W., pressures of 5 and 7 lbs. From October 15 to 20, a strong wind blowing from the S.W., pressures of from 5 to 10 lbs. were registered; and on December 6 and 7, the wind again prevailing from the S.W., pressures of from 6 to 13 lbs.

The following exhibits the extreme pressure of the wind in pounds on the square foot, for all the strong winds in every month during the twenty years in which the pressure has reached five pounds on the square foot.

		Pressures varying from	
1841.	January ...	5 to 10 lbs.	S.W.
	February	5 to 14 lbs.	E.N.E.
	March ...	5 to 9 lbs.	S.S.W.
	September	5 to 7 lbs.	S.W.
	October ...	5 to 7 lbs.	W.S.W.
	November	5 to 24 lbs.	S.S.W.
1842.	January ...	6 to 18 lbs.	S.W.
	February	5 to 9 lbs.	S.W.
	March ...	5 to 21 lbs.	S.W.
	September	10 to 12 lbs.	S.W.
1843.	January ...	7 to 25 lbs.	W.S.W.
	February	5 to 21 lbs.	N.E.
	March ...	5 to 9 lbs.	E.N.E.
	April	5 to 13 lbs.	W.S.W.
	June	5 to 7 lbs.	S.W.
	October ...	5 to 8 lbs.	S.W.
	November	5 to 12 lbs.	S.W.
	December	5 to 7 lbs.	S.
1844.	January ...	5 to 12 lbs.	N.W.
	February	5 to 12 lbs.	S.W.
	March ...	5 to 17 lbs.	W.
	May	5 to 9 lbs.	N.
	June	6 to 8 lbs.	S.W.
	July	5 to 10 lbs.	W.
	August ...	5 to 10 lbs.	S.W.
	October ...	5 to 8 lbs.	S.W.
	November	5 to 7 lbs.	E.
1845.	January ...	5 to 13 lbs.	W.N.W.
	March ...	5 to 10 lbs.	N.E.
		5 to 10 lbs.	S.W.
	April	5 to 12 lbs.	W.
	May	5 to 10 lbs.	N.
	July	5 to 9 lbs.	W.S.W.
	August ...	5 to 7 lbs.	W.S.W.
	September	5 to 8 lbs.	S.S.W.
1846.	January ...	5 to 12 lbs.	S.W.
	February	5 to 7 lbs.	W.S.W.
	March ...	5 to 11 lbs.	S.W.
	April	5 to 11 lbs.	W.S.W.
	July	5 to 9 lbs.	S.W.
	October ...	5 to 8 lbs.	S.W.
	November	5 to 10 lbs.	S.S.W.
1847.	January ...	5 to 12 lbs.	S.S.W.
	February	5 to 18 lbs.	W.S.W.
	April	5 to 15 lbs.	W.S.W.
	May	5 to 8 lbs.	S.S.W.
	September	5 to 12 lbs.	W.S.W.

		Pressures varying from	
1847.	October ...	5 to 8 lbs.	S.
	November	5 to 6 lbs.	S.S.W.
	December	5 to 13 lbs.	S.S.W.
1848.	January ...	5 to 6 lbs.	N.E.
	February	11 to 13 lbs.	S.W.
	March ...	5 to 8 lbs.	S.W.
	April	5 to 6 lbs.	S.W.
	May	5 to 7 lbs.	S.W.
	June	11 to 13 lbs.	S.W.
	July	6 to 9 lbs.	S.W.
	August ...	5 to 8 lbs.	S.S.W.
	October ...	8 to 10 lbs.	S.
	November	7 to 9 lbs.	S.W.
	December	5 to 12 lbs.	S.W.
1849.	January ...	9 to 15 lbs.	W.
	February	8 to 22 lbs.	S.W.
	March ...	5 to 8 lbs.	S.W.
	April	5 to 8 lbs.	S.W.
	May	6 to 12 lbs.	S.W.
	October ...	8 to 15 lbs.	S.W.
	December	6 to 14 lbs.	S.W.
1850.	January ...	5 to 7 lbs.	S.W.
	February	5 to 25 lbs.	S.W.
	March ...	5 to 6 lbs.	N.N.W.
	April	6 to 15 lbs.	S.W.
	May	5 to 6 lbs.	N.E.
	June	5 to 8 lbs.	S.W.
	July	5 to 6 lbs.	N.
	August ...	5 to 7 lbs.	S.W.
	September	5 to 6 lbs.	S.W.
	October ...	7 to 16 lbs.	W.
	November	5 to 19 lbs.	S.W.
	December	6 to 10 lbs.	S.W.
1851.	January ...	5 to 10 lbs.	S.W.
	February	5 to 8 lbs.	S.W.
	March ...	5 to 10 lbs.	S.W.
	April	5 to 6 lbs.	N.
	May	5 to 8 lbs.	W.S.W.
	June	5 to 8 lbs.	S.W.
	August ...	5 to 11 lbs.	S.W.
	November	5 to 6 lbs.	N.
	December	5 to 9 lbs.	S.S.W.
1852.	January ...	5 to 16 lbs.	S.W.
	February	5 to 10 lbs.	W.S.W.
	April	5 to 9 lbs.	E.
	May	5 to 10 lbs.	S.W.
	June	5 to 7 lbs.	S.S.E.
	August ...	5 to 16 lbs.	S.

		Pressures varying from	
1852.	September	5 to 7 lbs.	S.W.
	October ...	6 to 10 lbs.	S.W.
	November	5 to 12 lbs.	S.W.
	December	5 to 24 lbs.	S.W.
1853.	January ...	5 to 12 lbs.	S.W.
	February	5 to 15 lbs.	N.
	March......	5 to 6 lbs.	N.W.
	April	5 to 8 lbs.	W.
	May	5 to 6 lbs.	N.
	June	5 to 12 lbs.	S.W.
	July	5 to 6 lbs.	S.W.
	August ...	5 to 11 lbs.	S.
	September	5 to 13 lbs.	W.
	October ...	5 to 8 lbs.	S.W.
	November	5 to 6 lbs.	N.W.
1854.	January	5 to 6 lbs.	N.E.
		5 to 6 lbs.	S.W.
	February	5 to 17 lbs.	W.
	April	5 to 7 lbs.	N.
	May	6 to 9 lbs.	S.W.
	September	5 to 7 lbs.	S.W.
	October ...	5 to 10 lbs.	W.N.W.
	November	5 to 12 lbs.	S.W.
	December	6 to 10 lbs.	W.
1855.	January ...	5 to 13 lbs.	W.
	April	5 to 15 lbs.	W.N.W.
	May	5 to 6 lbs.	W.
	October ...	5 to 14 lbs.	W.
	December	5 to 10 lbs.	W.
1856.	January ...	5 to 15 lbs.	S.S.W.
	February	5 to 10 lbs.	S.W.
	March ...	5 to 6 lbs.	E.N.E.
	April	5 to 10 lbs.	N.E.
	May	5 to 16 lbs.	S.W.
	June	5 to 10 lbs.	S.W.
	July	5 to 10 lbs.	W.N.W.

		Pressures varying from	
1856.	November	5 to 7 lbs.	W.N.W.
	December	5 to 11 lbs.	S.W.
1857.	January ...	5 to 12 lbs.	S.W.
	March ...	5 to 13 lbs.	S.W.
	April	5 to 6 lbs.	W.
	July	5 to 6 lbs.	S.W.
1858.	January ...	5 to 6 lbs.	W.
	March ...	5 to 6 lbs.	W.N.W.
	April	5 to 6 lbs.	S.E.
	July	5 to 15 lbs.	S.W.
	September	5 to 9 lbs.	S.W.
	October ...	5 to 14 lbs.	S.W.
	November	5 to 13 lbs.	N.E.
	December	6 to 16 lbs.	S.W.
1859.	January ...	5 to 18 lbs.	S.W.
	February	8 to 16 lbs.	S.W.
	March ...	5 to 15 lbs.	S.W.
	April	7 to 13 lbs.	W.
	May	5 to 7 lbs.	N.E.
	July	5 to 8 lbs.	S.W.
	August ...	5 to 7 lbs.	W.S.W.
	September	5 to 8 lbs.	S.W.
	October ...	5 to 13 lbs.	S.W.
	November	5 to 20 lbs.	S.W.
	December	6 to 12 lbs.	S.W.
1860.	January ...	5 to 17 lbs.	S.W.
	February	5 to 28 lbs.	W.
	March ...	5 to 16 lbs.	W.
	April ...	5 to 12 lbs.	N.E.
		5 to 12 lbs.	S W.
	May	6 to 23 lbs.	W.
	June	5 to 23 lbs.	S.W.
	August ...	5 to 9 lbs.	S.W.
	October ...	5 to 10 lbs.	S.W.
	December	6 to 13 lbs.	S.W.

Frequency of High Winds and Gales, with different directions of the Wind.

By collecting all the cases which have happened in these 20 years under each direction of the wind, there are found to be—

5 from the S.:—

3 from	7 to 8 lbs.
1 of	11 lbs.
1 of	16 lbs.

12 from the S.S.W.:—

6 from	7 to 9 lbs.
3 from	10 to 13 lbs.
2 of	15 lbs.
1 of	24 lbs.

85 from the S.W.:—

27 from	7 to 8 lbs.
34 from	9 to 12 lbs.
12 from	13 to 16 lbs.
7 from	16 to 19 lbs.
1 of	20 lbs.
1 of	21 lbs.
1 of	22 lbs.
1 of	24 lbs.
1 of	25 lbs.

11 from the W.S.W.:—
- 4 from .... 7 to 8 lbs.
- 4 from .... 9 to 12 lbs.
- 1 of .... 13 lbs.
- 1 of .... 18 lbs.
- 1 of .... 25 lbs.

18 from the W.:—
- 4 from .... 7 to 8 lbs.
- 4 from .... 9 to 12 lbs.
- 8 from .... 13 to 17 lbs.
- 1 of .... 23 lbs.
- 1 of .... 28 lbs.

6 from the W.N.W.:—
- 2 from .... 7 to 9 lbs.
- 3 from .... 10 to 13 lbs.
- 1 of .... 15 lbs.

3 from the N.W.:—
- 2 from .... 7 to 9 lbs.
- 1 of .... 12 lbs.

1 from the N.N.W. of ... 6 lbs.

8 from the N.:—
- 6 from .... 7 to 9 lbs.
- 1 of .... 10 lbs.
- 1 of .... 15 lbs.

9 from the N.E.:—
- 6 from .... 7 to 10 lbs.
- 2 of .... 12 & 13 lbs.
- 1 of .... 21 lbs.

3 from the E.N.E.:—
- 2 from .... 7 to 9 lbs.
- 1 of .... 14 lbs.

2 from the E.:—
- 1 of .... 7 lbs.
- 1 of .... 9 lbs.

1 from the S.E. of .... 6 lbs.

1 from the S.S.E. of ...... 7 lbs.

So that in 20 years the wind has blown—

Once from the	W.	with a pressure of	28 lbs.
„	S.W.	„	25 lbs.
„	W.S.W.	„	25 lbs.
„	S.S.W.	„	24 lbs.
„	N.E.	„	21 lbs.
„	S.	„	16 lbs.
„	W.N.W.	„	15 lbs.
„	N.	„	15 lbs.
„	E.N.E.	„	14 lbs.
„	N.W.	„	12 lbs.
„	E.	„	9 lbs.
„	S.S.E.	„	7 lbs.
„	N.N.W.	„	6 lbs.
„	S.E.	„	6 lbs.

and there were no pressures to 5 lbs. from either of the two remaining points, viz. N.N.E. and E.S.E.

During the 20 years, or 240 months, pressures to 5 lbs. have been recorded in 160 months, or 2 out of 3.

Frequency of High Winds and Gales, in the different Months of the Year.

By collecting all pressures, independently of direction, in every month, in all the years, and arranging them in the order of magnitude, the following results are obtained:—

The greatest pressure of the wind in—

January	1848, 1854, and 1858	was	6 lbs.
	1850	was	7 lbs.
	1841 and 1851	was	10 lbs.
	1844, 1846, 1847, 1853, and 1857	was	12 lbs.
	1845 and 1855	was	13 lbs.
	1849 and 1856	was	15 lbs.
	1852	was	16 lbs.
	1860	was	17 lbs.
	1842 and 1859	was	18 lbs.
	1843	was	25 lbs.
February	1845, 1855, 1857, and 1858	was less than	5 lbs.
	1846	was	7 lbs.
	1851	was	8 lbs.
	1842	was	9 lbs.
	1852 and 1856	was	10 lbs.
	1844	was	12 lbs.
	1848	was	13 lbs.
	1841	was	14 lbs.
	1853	was	15 lbs.
	1859	was	16 lbs.
	1854	was	17 lbs.
	1847	was	18 lbs.
	1843	was	21 lbs.
	1849	was	22 lbs.
	1850	was	25 lbs.
	1860	was	28 lbs.
March	1847, 1852, 1854, and 1855	was less than	5 lbs.
	1850, 1853, 1856, and 1858	was	6 lbs.
	1848 and 1849	was	8 lbs.
	1841 and 1843	was	9 lbs.
	1845 and 1851	was	10 lbs.
	1846	was	11 lbs.
	1857	was	13 lbs.
	1859	was	15 lbs.
	1860	was	16 lbs.
	1844	was	17 lbs.
	1842	was	21 lbs.
April	1841, 1842, and 1844	was less than	5 lbs.
	1848, 1851, 1857, and 1858	was	6 lbs.
	1854	was	7 lbs.
	1849 and 1853	was	8 lbs.
	1852	was	9 lbs.
	1856	was	10 lbs.

The greatest pressure of the wind in—

April	1846	was	11 lbs.
	1845 and 1860	was	12 lbs.
	1843 and 1859	was	13 lbs.
	1847, 1850, and 1855	was	15 lbs.
May	1841, 1842, 1843, 1846, 1857, and 1858	was less than	5 lbs.
	1850, 1853, and 1855	was	6 lbs.
	1848 and 1859	was	7 lbs.
	1847 and 1851	was	8 lbs.
	1844 and 1854	was	9 lbs.
	1845 and 1852	was	10 lbs.
	1849	was	12 lbs.
	1856	was	16 lbs.
	1860	was	23 lbs.
June	1841, 1842, 1843, 1846, 1847, 1849, 1854, 1855, 1857, 1858, and 1859	was less than	5 lbs.
	1843 and 1852	was	7 lbs.
	1844, 1845, 1850, and 1851	was	8 lbs.
	1856	was	10 lbs.
	1853	was	12 lbs.
	1860	was	23 lbs.
July	1841, 1842, 1843, 1847, 1849, 1851, 1852, 1854, and 1855	was less than	5 lbs.
	1850, 1853, and 1857	was	6 lbs.
	1859	was	8 lbs.
	1845, 1846, 1848, and 1860	was	9 lbs.
	1844 and 1856	was	10 lbs.
	1858	was	15 lbs.
August	1841, 1842, 1843, 1846, 1847, 1849, 1854, 1855, 1856, 1857, and 1858	was less than	5 lbs.
	1845, 1850, and 1859	was	7 lbs.
	1848	was	8 lbs.
	1844	was	10 lbs.
	1851 and 1853	was	11 lbs.
	1852	was	16 lbs.
September	1843, 1844, 1846, 1848, 1849, 1851, 1855, 1856, 1857, and 1860	was less than	5 lbs.
	1850	was	6 lbs.
	1841, 1852, and 1854	was	7 lbs.
	1845, and 1859	was	8 lbs.
	1858	was	9 lbs.
	1842, and 1847	was	12 lbs.
	1853	was	13 lbs.
October	1842, 1845, 1851, 1856, and 1857	was less than	5 lbs.
	1841	was	7 lbs.
	1843, 1844, 1846, 1847, and 1853	was	8 lbs.
	1848, 1852, and 1854	was	10 lbs.
	1859	was	13 lbs.

The greatest pressure of the wind in—

October	1855 and 1858	was	14 lbs.
	1849	was	15 lbs.
	1850	was	16 lbs.
November	1842, 1845, 1849, 1855, 1857, and 1860	was less than	5 lbs.
	1847, 1851, and 1853	was	6 lbs.
	1844, and 1856	was	7 lbs.
	1848	was	9 lbs.
	1846	was	10 lbs.
	1843, 1852, and 1854	was	12 lbs.
	1858	was	13 lbs.
	1850	was	19 lbs.
	1859	was	20 lbs.
	1841	was	24 lbs.
December	1841, 1842, 1844, 1845, 1846, 1853, and 1857	was less than	5 lbs.
	1843	was	7 lbs.
	1851	was	9 lbs.
	1850, 1854, and 1855	was	10 lbs.
	1856	was	11 lbs.
	1848, and 1859	was	12 lbs.
	1847 and 1860	was	13 lbs.
	1849	was	14 lbs.
	1858	was	16 lbs.
	1852	was	24 lbs.

The pressure of the wind never reached 5 lbs. in—

January	0 years out of 20	July	10 years out of 20
February	4 years out of 20	August	11 years out of 20
March	4 years out of 20	September	10 years out of 20
April	3 years out of 20	October	5 years out of 20
May	6 years out of 20	November	6 years out of 20
June	11 years out of 20	December	7 years out of 20

January, therefore, is distinguished as the only month during these 20 years in which the pressure of the wind has always exceeded 5 lbs.; the next in order of frequency of strong winds or gales have been February, March, and April; then May and the last three months of the year, which four months are of nearly equal frequency. The remaining months, viz. June, July, August, and September, are distinguished by being the most free from strong winds, and to a very nearly equal degree.

From the preceding it would seem that the months free from strong winds have been, one February and March in 5 years; one April in 6¾ years; one May, October, November, and December in 3 years; one June, July, August, and September in 2 years.

The following Table shows the maximum pressure of the wind (when 5 lbs. and upwards) in every month in the years 1841 to 1860:—

TABLE showing the extreme Pressures of the Wind in every Month in the 20 Years, when the pressure has reached 5 lbs. on the square foot, independent of direction.

Month.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
January	10	18	25	12	13	12	12	6	15	7	10	16	12	6	13	15	12	6	18	17
February ...	14	9	21	12		7	18	13	22	25	8	10	15	17		10			16	28
March	9	21	9	17	10	11		8	8	6	10		6			6	13	6	15	16
April			13		12	11	15	6	8	15	6	9	8	7	15	10	6	6	13	12
May				9	10		8	7	12	6	8	10	6	9	6	16			7	23
June			7	8				13		8	8	7	12			10				23
July				10	9	9		9		6			6			10	6	15	8	
August				10	7			8		7	11	16	11						7	9
September ...	7	12			8		12			6		7	13	7				9	8	
October	7		8	8		8	8	10	15	16		10	8	10	14			14	13	10
November ...	24		12	7		10	6	9		19	6	12	6	12		7		13	20	
December ...			7				13	12	14	10	9	24		10	10	11		16	12	13

The blank spaces in this Table show that in those months the pressure of the wind has never reached 5 lbs. on the square foot.

From this Table we see that in some years, as in 1841, 1842, 1843, 1846, 1849, 1855, 1856, 1857, no pressure has reached 5 lbs. for several months together, whilst in other years, as in 1848, 1853, and 1859, this pressure has been exceeded in every month but one, and in 1850 in every month without exception. A marked difference seems to have taken place between the year 1848 and 1853 in the frequency of strong winds, both from the preceding and following years. The year 1860, the last of the series, is distinguished by the heaviest pressure in the 20 years, viz. 28 lbs. in the month of February; and this year is no less remarkable for pressures of 23 lbs. in both May and June, whilst generally, as will be seen by casting the eye along the horizontal lines of the preceding Table in those months, the extreme pressure is usually very much less.

From the preceding Table we readily pick out the maximum pressure of each year, and month of occurrence, as follows:—

In the year—	In the year—
1841 was 24 lbs. in November.	1851 was 11 lbs. in August.
1842 was 21 lbs. in March.	1852 was 24 lbs. in December.
1843 was 25 lbs. in January.	1853 was 15 lbs. in February.
1844 was 17 lbs. in March.	1854 was 17 lbs. in February.
1845 was 13 lbs. in January.	1855 was 15 lbs. in April.
1846 was 12 lbs. in January.	1856 was 16 lbs. in May.
1847 was 18 lbs. in February.	1857 was 13 lbs. in March.
1848 was 13 lbs. in Feb. and June.	1858 was 16 lbs. in December.
1849 was 22 lbs. in February.	1859 was 20 lbs. in November.
1850 was 25 lbs. in February.	1860 was 28 lbs. in February.

The difference between these pressures is very great; from them we learn that the greatest pressure of the wind in the year—

1851	was 11 lbs.	1859	was 20 lbs.
1846	was 12 lbs.	1842	was 21 lbs.
1845, 1848, and 1857	was 13 lbs.	1849	was 22 lbs.
1853 and 1855.........	was 15 lbs.	1841 and 1852.........	was 24 lbs.
1856 and 1858.........	was 16 lbs.	1843 and 1850.........	was 25 lbs.
1844 and 1854.........	was 17 lbs.	1860	was 28 lbs.
1847	was 18 lbs.		

It is also to be noted that the light pressures, with the exception of the year 1851, are in groups, as in the years 1844 to 1848 the maximum pressures are between 13 lbs. and 18 lbs., and, again, in the years 1853 to 1858 the greatest pressures are between 13 lbs. and 17 lbs.; whilst in the years 1841 to 1843 they are from 21 lbs. to 25 lbs., in 1849 to 1852 (with the remarkable exception of the year 1851) they are 22 lbs. to 25 lbs., and in the last two years 20 lbs. and 28 lbs.

In this paper I have been unable to include any results showing

either the actual number of hours the wind has blown in each direction in each year, or the total sums of the pressures due to each wind, or several other results necessary to be deduced, owing to the want of time at my disposal to discuss hourly observations in so many different elements, extending over so long a period as twenty years; but I hope to be able to do so, and to have the honour at some future time of laying the results before this Society.

IX. *On the Moon's Influence over the Temperature of the Air.*

By J. PARK HARRISON, Esq., M.A.

THE investigation into the influence of the moon over the mean temperature of the day, which was commenced in 1856, has now been continued up to the beginning of November 1861.

It will be sufficient on the present occasion to state very briefly the results which from time to time have been announced as ascertained meteorological facts: viz., that the greatest amount of heat displays itself in the earlier part of the lunation; the greatest amount of *cold* about the period of full moon, and shortly after the last quarter; and, lastly, that the comparative coolness of the air at these periods is traceable to a greater clearness of the atmosphere, and increased radiation into space.

Upon tabulating the daily mean temperatures at Greenwich for the last four years, in the way that appeared best adapted for the purpose of detecting lunar influence*, further results have been obtained which confirm the conclusions previously arrived at for the years 1814–1856.

Taking the mean temperatures of six days at first quarter, and six days at last quarter during 48 consecutive lunations (from the second day before to the third day after each of those phases in 1858–1861), on a comparison of the sums of the mean temperatures at each period, a difference in defect is found to occur at the last quarter amounting to 513°·0 Fahr.

This difference is very nearly the same as that previously ascertained between the sums of the observations of mean tempe-

* The observations have been throughout arranged in columns appropriated to the proximate days of the lunations, in groups containing the moon's four principal phases as centres. See Report of the British Association for the Advancement of Science, 1860, and plate; and Philosophical Magazine, March 1859.

rature on the day of maximum heat at the period of first quarter, and the day of minimum heat at the period of last quarter in the years 1814 to 1856, viz. 520°·0, or a mean difference of 1°·0 Fahr. The mean difference of the same two days in the years 1858–1861 is 2°·3.

In 1859 the difference between the mean of the day of maximum mean temperature at first quarter and the mean of the day of minimum mean temperature at last quarter was 4°·5; the difference between the means of the minimum temperatures of twelve lunations, in the same year, for the same days, was 7°·5; and the arithmetic mean of the maximum and minimum self-registering thermometers 5°·4, on an average of twelve observations.

In view of these results, it became a question of much interest and importance whether the reduction in the value of the differences in a long series of years depends on periodic causes, or whether it is owing to any inherent fault in the earlier series of Greenwich observations, rendering them ill-fitted for an investigation into lunar influence. It will probably be seen, on a careful examination of the figures and symbols in the annexed Table, that something is due to both causes.

But before directing attention to the particular points which seem to indicate this, it will be necessary to explain that the observations used in this inquiry are those which Mr. Glaisher determined with so much zeal and labour for this Society in 1857. It will be remembered that in different groups of years observations were stated to have been taken at different hours of the day; and it is particularly to be noted that the results deduced from the maximum and minimum thermometers previous to 1841 were found to be so often discordant, that no use was made of them in determining the true mean temperatures of the day for the series of years between 1814 and 1841. In addition to this, for a considerable portion of the same series of years, *no observations were registered after* 6 P.M., and during the 4 years ending 1840, no observations were taken after *two* o'clock in the afternoon.

To obtain the true mean daily values for these years, Mr. Glaisher applied corrections calculated from his Tables of diurnal range, published in the 'Philosophical Transactions' for the year 1848, "depending upon the time at which the observations were taken at the different periods." No corrections were made for lunar influence; nor in the absence of proper tables was this possible, even if it had been suspected that such corrections were required.

Such being the history of the observations used, it remains to point out the principle on which the Table of the sums and differences between the sums of the mean temperatures at first and last quarter has been constructed.

The observations of daily mean temperature for each year having been first arranged in columns, appropriated to the three days of the lunation at first and last quarter selected for comparison, the sums of the columns at each period were added together, and their sums are inserted in the Table under the headings relating to them, and also the sums for each quinquennial period. The differences between the annual sums of mean temperature at the two periods of first and last quarter, and the sums of the differences for the several series of years (for the most part decennial), are inserted in the remaining columns.

On examining the Table, it will at once be perceived that the number of *minus* signs, indicating cold at the last quarter, is far greater than the number of *plus* symbols signifying heat, not only in the decennial periods, but also in the case of the annual differences between the sums of mean temperature at first and last quarter. The sum of the differences of the 3-day periods for the whole of the 578 lunations under review, amounts to 1228°·4 Fahr., of which 812°·1 belongs to the period between 1839 and 1861, and 416°·2 only to the period 1814–1839.

During the first ten years of this latter period observations were made at Greenwich as late as 10 P.M., and the sum of the difference between the decennial sums of mean temperature at first and last quarter is 333°·1.

In the next decennial period, during six out of the ten years observations were still made at 10 P.M., but during the remaining four years the latest hour at which the thermometer was read appears to have been 6 P.M., and the difference between the sums of mean temperature is reduced (apparently from this cause and more frequent day observations) to 110°·3.

In the five years ending January 1840, *no* observations were taken at Greenwich after 2 P.M., and it is worth especial notice that at this period the signs become changed; the difference is no longer minus, but +27°·1. This is the only instance in the 47 years of the sum of the differences in any quinquennial period being in excess at last quarter.

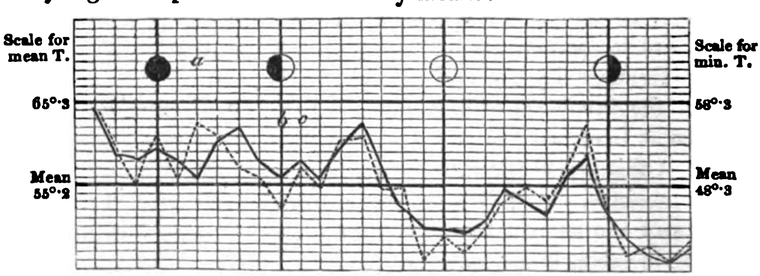
The fact, indeed, is rendered still more significant by the result of the comparison in the succeeding decennial period. During seven of these years 2-hourly observations were taken at Greenwich,

both by day and night, and the difference of the sums at the first and last quarter is 533°·7.

For the remaining 12 years, from 1840 to 1861, the observations were taken at 9 A.M., at noon, at 3 P.M., and at 9 P.M. The result is a difference of 278°·4. During this period the maximum and minimum temperatures were used in determining the mean temperature, but corrections were applied which were necessarily irrespective of lunar influence.

The differences of the sums of mean temperature of the three days after first quarter and the three corresponding days after *full moon* present even more striking results. On a total difference of about 800°·0 at full moon, between the sums of the mean temperatures at the two periods during 47 years, less than 100° are found to occur between 1814 and 1839; and in three of the quinquennial periods the difference is in excess at full moon,—thus affording indirect evidence of the comparative absence of cloud at that phase, from the very circumstance that in clear weather the day observations would naturally increase in value with increased solar radiation, and in the absence of any record of the minimum temperatures no corrections would compensate for the absence of the effects produced by a clear sky at night. Indeed, the bi-horary observations of cloud in 1840 to 1847 at Greenwich, and a valuable series of observations taken at Frodsham in Cheshire, by the Rev. N. E. Page, the vicar of the parish, in 1784–1798*, have been found strongly to confirm the conclusion that the minimum of cloud is to be looked for shortly after full moon and last quarter, and the maximum at first quarter.

Lunar curves of the mean and of the minimum temperatures in last October afford a striking instance of the influence exerted by night temperatures on the daily means:—



a. Interval 6 d. 15 h. 13 m. *b*. On this day an aurora: magnets disturbed.
c. Thunder-storm. Clear at night.
NOTE.—The dotted line is the curve of minimum temperature.

* Lent to the author by Dr. William Page, M.D.

Table showing the difference between the Mean Temperature of the 8 days following on ☽ and ☾, for 47 years, at Greenwich.

	Year.	Annual sums at ☽.		Annual Sums at ☾.		Difference of sums at ☽ and ☾.	Sums of difference.
	*1815.	1747·3		1729·8		° − 17·5	
+	+1816.	1750·9		1811·9		+ 61·0	
	1817.	1741·0	8990°·9	1728·5	8853°·7	− 12·5	
	1818.	1863·6		1786·8		− 76·8	
	1819.	1888·1		1796·7		− 91·4	
	1820.	1826·7		1741·8		− 84·9	−333°·1
	1821.	1749·8		1674·9		− 74·9	
	1822.	1790·6	9118°·0	1876·0	8922°·1	+ 85·4	
	1823.	1871·3		1826·9		− 44·4	
	1824.	1879·6		1802·5		− 77·1	
+	1825.	1931·4		1961·8		+ 30·4	
	1826.	1828·4		1830·7		+ 2·3	
	1827.	1790·4	9246°·3	1773·5	9205°·8	− 16·9	
	1828.	1935·1		1902·7		− 32·4	
	1829.	1761·0		1737·1		− 23·9	
	1830.	1863·6		1788·5		− 75·1	−110·3
	1831.	1725·7		1778·0		+ 52·3	
	1832.	1741·5	9090°·0	1695·1	9020°·2	− 46·4	
	1833.	1921·1		1881·6		− 39·5	
+	1834.	1838·1		1877·0		+ 38·9	
	1835.	1806·7		1793·5		− 13·2	
	1836.	1840·7		1851·6		+ 10·9	
	+1837.	1747·7	8896°·2	1775·5	8923°·3	+ 27·8	+ 27·1 †
	1838.	1662·7		1670·7		+ 8·0	
	1839.	1838·4		1832·0		− 6·4	
	1840.	1824·8		1712·3		−112·5	
	1841.	1924·2		1879·0		− 45·2	
	1842.	1753·6	9234°·9	1730·4	9046°·6	− 23·2	
+	1843.	1784·3		1822·6		+ 38·3	
	1844.	1948·0		1902·3		− 45·7	
	1845.	1729·2		1631·5		− 97·7	−533·7
	1846.	2038·8		1966·7		− 72·1	
	1847.	1763·7	9383°·4	1676·6	9038°·0	− 87·1	
	1848.	1864·0		1806·6		− 57·4	
	1849.	1987·7		1956·6		− 31·1	
	1850.	1756·2		1765·0		+ 8·8	
	1851.	1957·3		1896·7		− 60·6	
+	1852.	1784·9	9210°·4	1800·3	9124°·4	+ 15·4	
	1853.	1783·0		1811·5		+ 28·5	
	1854.	1929·0		1850·9		− 78·1	
	1855.	1760·7		1735·6		− 25·1	−278·4
	1856.	1786·6		1756·4		− 30·2	
	+1857.	1792·5		1913·5		+121·0	
	1858.	1852·4	12772°·9	1751·4	12583°·8	−101·0	
	1859.	2012·5		1971·6		− 40·9	
	1860.	1733·2		1615·3		−117·9	
+	1861.	1835·0		1840·0		+ 5·0	

Note.—The sign + indicates that the mean temperature at last quarter is higher than at the first quarter. The sign − signifies that it is lower.

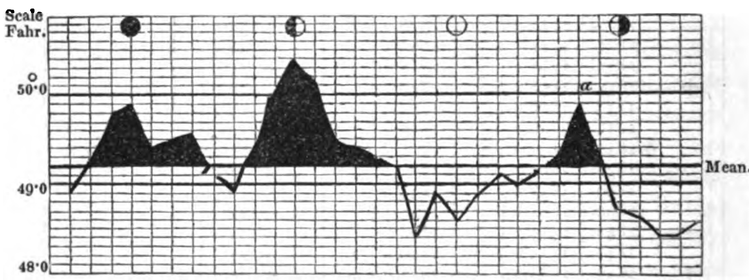
* Several doubtful observations occur in this and other years, between 1814 and 1841.

† 5 years only.

A curve for the years 1840–1847 is appended. It is formed from the mean temperatures of the day at Greenwich derived from observations taken day and *night* every two hours, excepting on Sundays, Christmas Day, and Good Friday.

In arranging the mean temperatures in tables, the four principal phases of the moon were taken as centres, and thus an equal number of observations of mean temperature was obtained on 28 days of the lunation. They amounted to 87. The surplus observations of mean temperature which fell midway between the four quarters have not been made use of. There were about 40, in the seven years, in each quarter. Their *means* at 1st and 3rd octant are found to fall below, and at 2nd and 4th octant to rise above the mean of the two adjoining days at each period.

Lunar Curve of Mean Temperature at Greenwich.



X. *On the Periodic Return of a Tide of Vapour.* By W. Bellingham, Esq.

[Abstract.]

The recurrence of phenomena indicating the existence of a tide or belt of vapoury clouds, traversing the atmosphere alternately from pole to pole, at regular intervals of 40 days, has for some years past attracted the author's attention.

This tide, which would pass and repass the latitude of Peru at intervals of 20 days, and may possibly be connected with the Peruvian period of 20 days, at intermediate regions between the equator and the poles would return at longer or shorter intervals, according to the latitude of the place.

For example, from the time it passes northwards over London, to its return to the same latitude, would be about 10 days, if it moved at an estimated rate of 20 miles in an hour; its next return after going S. would occur in about 30 days.

Owing to many counteracting influences, it would be difficult to predict the effects of the tide. Under certain conditions of the atmosphere, however, it would probably produce storms and rain. Though the belt of vapour is supposed to be continuous, it is probable that some parts of it would be considerably in advance of others, in those regions where least resistance is offered to its progress.

A lunar atmospheric tide, assuming one to follow the moon in her declinations, would also result in an alternate movement of the atmosphere N. and S., in a period of about 27 days. This, and the supposed periodic tide of 40 days, would sometimes combine their effects, and at other times be in opposition.

The author's data on which he founds his theory are his observations of the periodicity of atmospheric phenomena at intervals of 10 and 30 days in the latitude of London.

XI. *Aurora in a Low Latitude*. By Charles Trevenen, Esq. Communicated by Alex. S. Herschel, Esq.

To the Secretary.

17 Delamere Terrace, Paddington, W.
June 16, 1861.

Allow me to offer to your notice the accompanying account of the auroral arch distinctly seen at a very low latitude, recently communicated to me.

It is interesting as succeeding at no great interval of time the great display of the 9th of March last, when an arch was seen in the midland and southern counties of England, that was computed, from observations made at London and Nottingham, to lie about halfway between those towns, at a height of about 83 miles above the earth. Of that arch I enclose an account for your comparison with the extract from the ship's log of March the 31st.

I have the honour to be, Sir,
Your obedient Servant,
Alex. S. Herschel.

"Hawkhurst, Kent, 1861, March 10, Sunday.—The aurora last night was perfectly magnificent. We all went out upon the Moor to see it. First a flaring unsteady blaze of crimson light, with whiter beams now and then appearing about it; and by and by a rather more steady beam shooting up much higher, and vanishing into thin air when it had well showed itself off; after which the general glow became less. In a few minutes it began to shoot again gloriously with streamers like waving corn; and presently a white arch began to be perceptible, which gradually became more and more distinct; and we watched the southern end *drifting southward* among the stars, first over the Pleiades and then over Aldebaran, while the crown of the arch remained pretty stationary upon the pole star and the north-western end upon α Lyræ: α Lyræ looked emerald-green amid the glow of red light at this point.

"The western end passed from the Pleiades to Aldebaran in about 10 minutes, and then it began to fork upwards on the southern side. Presently the fork detached itself and a fresh barb grew out, and then these reunited; and this was repeated while the end *shifted more and more to the south* with red and white streamers and flashes, the arch only lasting for about a ¼ of an hour." A. S. H.

"March 31, 1861, Easter Sunday.

"Ship 'Hotspur,' standing to the N.W., in lat. 7° 40′ N., long. 25° W., Atlantic wind blowing from about N.N.E.

"This evening, at about 6^h 20^m P.M., the sun at the time being set and the moon not risen by about 3^h, a peculiar white bow in the form of a rainbow was seen stretching from horizon to horizon, the eastern extremity bearing about N.E., and the western about S.W.

"At 6^h 30^m P.M. the bow had, by travelling in a S.E. direction, passed abaft the foremast, and the eastern extremity was still touching the horizon, although the western extremity did not touch by nearly 50°.

"At 6^h 45^m P.M. the bow had greatly diminished; especially now from the eastern end, and its position was abaft the mainmast. At the time of its disappearance, being half an hour from its first showing itself, it had diminished to a very small spot over the mizenmast.

"The sky was bright over head, but covered with black and white clouds to the westward.

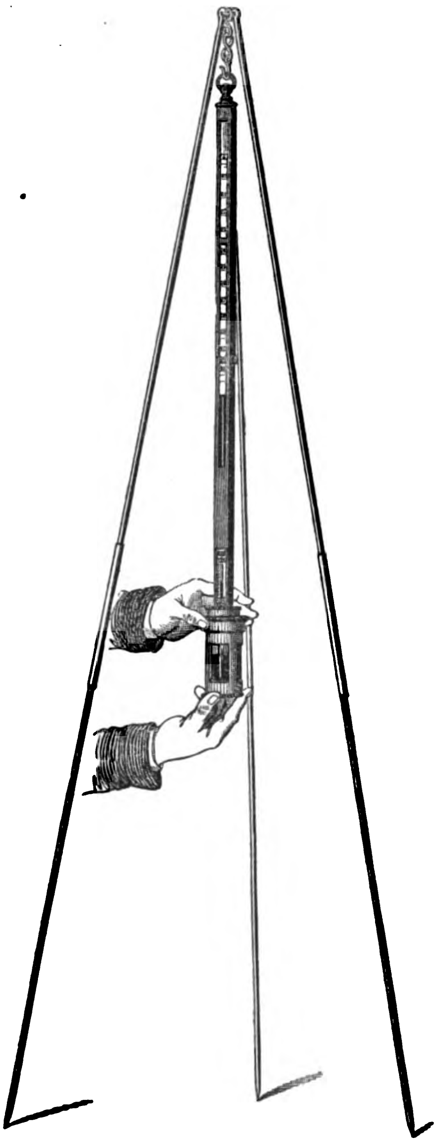
"Such a sight had not been seen by any of the hands; and some had cruised about this spot for 20 years.

"The ship was running 8 knots N.W., bar. 29·86 in., aneroid 29·75, therm. 81°."

XII. *Description of a New Travelling and Standard Barometer.* By Messrs. Negretti and Zambra.

To enter fully into the special features of this barometer, the defects of the old construction ought to be pointed out. It is well known that in sending barometers abroad, although the greatest precaution may be taken, by carefully packing the instrument on springs, still on an average not one-half of the barometers reach their destination in safety. This is mainly attributable to the breaking of the tube by concussion, or by the mercury striking the top of the tube. The breaking of the tube by the latter cause is effected, even whilst the barometer is lying in a horizontal position. If, for instance, a package containing a barometer is laid lengthways in a railway train, with the cistern end of the instrument towards the engine, a sudden stoppage, or even a slackening of speed, or the engine backing the train and giving the carriages a sudden push—such a trifle in itself as either of these is sufficient to break off the top of the tube, by the mercury being suddenly brought away from the end (by reason of the elasticity of the leather bag) and rushing back to its original position. Nine-tenths of the breakages can clearly be traced to the above cause. The late Mr. Newman (to whose business Messrs. Negretti and Zambra have succeeded) attempted to remedy the defect of the old cistern with leather bag, by making his well-known iron-cistern barometer. This improvement in some measure remedied the defect; but it gave rise to a great source of error from leakage of mercury, which alters the neutral point of the instrument: moreover scientific men do not like to implicitly rely on the *supposed* accuracy of any instrument, but generally wish it so constructed that they may themselves be enabled to test its accuracy. The barometer that has met with the greatest patronage of late years is the one made on Fortin's principle, where an ivory point is permanently fixed to the barometer-frame, and the mercury is brought in contact by means of a screw acting upon a leather bag. In this barometer, the observer can by an accurate rule or

cathetometer easily satisfy himself as to the accuracy of his instrument, by measuring the distance between the point and the divisions, and seeing if the reading is identical with the indication given. This barometer, owing to its having a leather bag, is but ill adapted for travelling. In consequence of the many breakages with the Fortin barometer, and the uncertainty of Newman's, the Council for India applied to Messrs. Negretti and Zambra to furnish a barometer of some new construction, not subject to the failings of the old barometers. The result of lengthened experiment has been the production of the barometer latterly patented by them, and exhibited to the Members of the British Meteorological Society. The principal conditions to be complied with were—1st, the production of a portable barometer, without a leather or elastic bag; and 2nd, the construction of a barometer that could be depended upon as a standard, without reference to any other.



This new barometer, of which the following is a description,

will be found to fulfil the above conditions. At the end of the barometer-frame, where the cistern is usually placed, an iron screw collar is cut, the diameter of which is about 1 inch, and its length 2 inches. It has about 20 threads to the inch. At the end of the screw is fixed an ivory zero-point from which the divisions of the barometer-scale are marked. Into the iron screw collar the tube containing the mercury is fixed, projecting below the screw about 2 inches.

The cistern is made partly of glass and partly of iron,—the glass portion being to enable the reading to be taken from the ivory point already mentioned. The top of the cistern carries a female screw fitting exactly on the iron collar at the bottom of the frame; so that the cistern can be raised or lowered at pleasure by screwing or unscrewing, which raises or lowers at the same time the mercury contained in the cistern, and thereby adjusts the zero-point previously to making an observation. This barometer, besides possessing the advantage of non-elasticity of cistern and of enabling the observer to read from a visible zero-point, can at any time be taken to pieces, and the cistern and mercury cleaned, as shown to the Members present at the meeting. Moreover, should the tube at any time get accidentally broken, a new tube can be fixed in by any person possessing the least capacity for such an operation. As to whether there is more or less mercury in the cistern it matters not, the readings being taken from the same point, and the screw collar being long enough to allow of provision being made against any casualty.

In cleaning the cistern, the barometer has to be turned upside-down and the cistern unscrewed from the frame, care being taken to catch the mercury in some glass or earthenware vessel. After cleaning the cistern out, it is again screwed on; and the mercury, after being filtered through a paper funnel, is poured in through a hole at the bottom of the cistern, a moveable screw being left for that purpose. The whole affair is so simple that no diagram, beyond a general design, has been thought necessary. It may as well be stated that this barometer is the adopted pattern of the East India Government.

BOOKS AND NOTICES.

IV. *Meteorological Tables for the Reduction of Barometrical and Hygrometrical Observations, determination of Heights by the Barometer and Boiling-point Thermometer, &c.* By G. HARVEY SIMMONDS. 8vo. pp. 46. 1861.

THE author, in his preface, says, "The whole of the Tables have been carefully computed, and those affected by the variation in the force of gravity for the mean latitude of 45°."

Table I. contains the corrections due to capillarity, or the amounts by which the mercury is depressed in barometer tubes of from $\frac{1}{10}$th to $\frac{6}{10}$ths of an inch in internal diameter.

Tables II., III., and IV. are respectively for reducing the readings of barometers with brass, glass, and wood scales to the standard temperature of 32° Fahrenheit; they are computed from Schumacher's formula; they embrace a range of from 11·5 inches to 31·0 inches of the barometer, and 0° to 100° of Fahrenheit's thermometer; but as barometers with glass and wooden scales are seldom used, "Tables III. and IV. have been made out for every 5° only, in order to save space."

Table V. is for reducing observations of the barometer made at any height not exceeding 500 feet to sea-level, and has been computed from Sir G. Schuckburgh's formula, written so as to give the difference of the readings of the barometers at the upper and lower stations, instead of the height of the former above the latter; the reduction is given for every 10° from −20° to +130° Fahrenheit; and as the correction for any given height varies with the pressure as well as with the temperature, the Table has been computed for pressures, at the lower station, of 30 and 27 inches.

Tables VI., VII., VIII., IX., and X. are for finding the difference of elevation between any two places by means of the barometer; they are based upon Laplace's formula.

Tables XI. and XII.—By these Tables the difference of level between two places may be obtained from the observed temperatures of boiling water; they are computed from the formula derived from M. Holtzman's experiments, and given by Mr. J. R. Christie in the 'Philosophical Transactions' for 1846.

Table XIII. contains the elastic force of aqueous vapour, derived from the experiments of M. Regnault, published in the '*Annales de Chimie et de Physique*,' série 3ᵉ. tom. xi.

Table XIV. gives the value for each 10° of temperature from −20° to +120°, and for each inch of the barometer from 31 to 25, of part of the second term of M. August's formula for finding the dew-point from observations made with Mason's hygrometer.

Table XV. gives the volume of a mass of dry air, which is taken as equal to 1 at 32°, for each degree of temperature from −20° to +120°, assuming that air expands 0·0020361 (M. Regnault) of its bulk at 32° for each increase of 1° of temperature.

Table XVI. shows the weight in grains of a cubic foot of dry air under a pressure of 30 in. from $-20°$ to $+120°$, the weight of a cubic foot at a temperature of $32°$ being assumed as 566·42 grs. The third, sixth, and ninth columns give the amount by which the weight is increased or diminished, according as the pressure rises above or falls below 30 inches, for a change of $\frac{1}{10}$th of an inch in the barometer.

Table XVII. gives the weight of a cubic foot of vapour, assuming that at $212°$ it weighs 257·13 grains.

Table XVIII. shows the weight of a cubic foot of air saturated with moisture under a pressure of 30 inches, from $-20°$ to $+120°$.

Table XIX. contains the excess of the weight of a cubic foot of dry air over that of a cubic foot of saturated air.

The weight of a cubic foot of atmospheric air may be determined from the last three Tables.

Table XX. shows the velocity in miles per hour with which the air is travelling when it exerts a given pressure in pounds avoidupois on a surface of a foot square.

"Tables XXI. and XXII. give the pressures in pounds, and velocities in miles per hour, corresponding to given heights of the column of water in Lind's Wind-Gauge (taking the weight of a cubic inch of water at $60°$ Fahrenheit as 252·53 grains), and to forces of the wind estimated by the usual land-scale of from 0 to 6."

"Table XXIII. shows the weight of water which any circular gauge, having a diameter between 4 and 24 inches, would collect, if rain sufficient to cover the ground to the depth of $\frac{1}{10}$th of an inch were to fall. The Table is computed for every $\frac{2}{10}$ths of an inch; the weight of water which would be collected by a gauge having a diameter intermediate to any of those in the table may be found by multiplying the quantity in column *d* by the difference between the diameter of the gauge and the nearest value to it in the table, and adding the result to, or subtracting it from, the weight given it in the table, according as the diameter of the gauge is greater or less than the tabular value."

Table XXIV. gives the value for each $5°$ of latitude of the second term of the expression $(1 \mp 0{\cdot}00268 \cos 2\angle)$, by which the quantities in the tables affected by the variation in the force of gravity are to be multiplied to obtain their values for any other latitude than that for which they are computed, viz. $45°$. The upper sign is to be taken when the value of a quantity increases from the equator to the poles; and the lower one when, on the contrary, it diminishes. In nearly all cases the tables may be used without taking into account this very minute correction.

V. *On certain Storms in Europe and America, December* 1836. By Elias Loomis, LL.D., from the 'Smithsonian Contributions to Knowledge.' Pp. 26. 4to. with 13 coloured plates. August 1859.

In 1838, Professor Loomis undertook the investigation of a violent storm which swept over the United States about the 20th of December 1836. The results at which he arrived were published in the 'Transactions of the American Philosophical Society,' vol. vii. pp. 125–163. The storm extended from the Gulf of Mexico to an unknown distance on the north. As the southern half only of the storm could be examined, he investigated the storm which occurred on February 4, 1842, and adopted the following mode of representing its principal features pictorially at intervals of 12 hours. Those portions of the map of the country, corresponding to places where the sky was unclouded, were coloured blue; where the sky was clouded, brown; where rain was falling, yellow; and where snow was falling, by a green colour. The direction of the wind was indicated by arrows, and its force represented by their length. The observations of the barometer were represented by lines, joining those places where the barometer at a given hour stood at its mean height. This line was called the *line of mean pressure*. In the same manner lines were drawn, connecting those places where the barometer at the same time stood $\frac{2}{10}$ths above the mean, $\frac{4}{10}$ths above the mean, &c., and $\frac{2}{10}$ths, &c., below the mean. These lines were called *lines of equal barometric disturbance*. A similar plan was adopted for showing the indications of the thermometer,—lines being drawn representing *lines of mean temperature*, and others the difference, from the average, of 10° and 20°, &c., which were styled *lines of equal thermometric disturbance*. Finding that this mode of representation was well calculated to exhibit the changes that occurred, Professor Loomis proceeded to analyse the American storm of December 20th, 1836, and the European storm of December 25th, which was by some meteorologists supposed to be a continuation of the former.

The American Storm. *Barometrical Fluctuations.*—Records were obtained from thirty-one stations, of which the latitude and longitude are given, together with the mean height of the barometer at each station, with its difference from the average at 8 A.M. and P.M., from December 19th to the 22nd inclusive. Five charts succeed, which show that on the evening of December 20th the area over which the barometer was below the mean was 980 miles from W. to E.; on the morning of December 21st, 770 miles from W. to E.; and on the evening of December 21st, 650 miles. The greatest observed depression was at Quebec, whence it is inferred that the area of low barometer probably extended as far N. as it did S. of Quebec. On this supposition, the area of low barometer, December 21st, extended about 3000 miles from N. to S. This area constituted an oblong-oval figure, whose length was from two to three times its breadth. This figure was not stationary, but travelled constantly eastward. From the de-

ficiency of observations at points N. of the centre of the storm, the direction and velocity of its motion could not be determined accurately; but most probably it was from S. 60° W. to N. 60° E. From the morning of December 20th to the morning of December 21st, the centre of the storm advanced, in the direction already assigned, 1050 miles, being an average velocity of forty-four miles per hour.

Thermometrical Fluctuations.—A similar discussion of the thermometrical observations at sixty stations shows that, on the evening of December 19th, the area of high thermometer extended from 800 to 1100 miles in an E. and W. direction; but at only three places did the thermometer rise as high as 10° above the mean. December 20th, the area of high thermometer, near the parallel of 40°, had contracted to a breadth of 570 miles; and at several places the thermometer stood more than 15° above the mean. On the morning of the 21st, the thermometer at several places stood more than 20° above the mean. Thus it appears that, near the centre of the storm, the heat had increased about 15° in 36 hours, from the evening of the 19th to the morning of the 21st. The centre of this area of high thermometer was uniformly somewhat to the eastward of the centre of the area of low barometer. On the morning of December 20th, near the parallel of 40°, it was 400 miles to the E., decreasing to 200 miles, near the parallel of 46°, on the morning of the 21st. On the eastern side of the storm, where the rain had not yet commenced, the thermometer stood 20° above its mean height; while on the western margin of the storm the thermometer sunk below its mean height before the rain and snow had ceased. On the evening of December 21st, the points of greatest heat and of least pressure probably differed but little in position, and over the greater part of the American continent the thermometer was from 10° to 30° below the average.

Face of the Sky.—On the evening of December 19th, rain or snow was falling throughout the entire region W. of the Mississippi, as far as observations extended; and cloud covered the entire United States, except those bordering on the Atlantic Ocean. On the morning of the 20th, the rain and snow had extended eastward as far as Cincinnati; and the cloud covered the entire United States, except New York and New England. On the evening of the 20th, the rain had extended eastward to Washington, while only a small portion of New England was free from cloud; an area of clear sky appears beyond Arkansas and Louisiana. On the morning of the 21st, the cloud had covered the whole of the eastern portion of the continent, while the sky was clear to the W. of Cincinnati. The rain now covered the whole of New England, except the State of Maine, while the western boundary of rain and snow had reached the middle of Lake Erie. On the evening of the 21st, the storm was confined to the eastern margin of the continent, while the western boundary of the rain had passed to the E. of the Connecticut River; and throughout the whole of the United States, except New England and two or three spots of limited extent, the sky was entirely free

from clouds. Throughout the entire United States the average amount of rain which fell during this storm was ⅞ths of an inch; and although the fall at different places was very unequal, still the average amount was sensibly the same on the eastern as on the western part of the country, and on the N. side nearly equal to that on the S. side.

Direction of the Wind.—On the evening of the 19th, throughout the area of rain and snow, the wind blew from the S. or S.E. On the E. side of the boundary of rain and snow, but within the limits of the cloud, the winds appear to have been somewhat influenced by the storm; in New England, the winds were W. inclining to N.W.

On the morning of the 20th, beyond the Mississippi River, the winds had changed to the N. and N.W.; but on the eastern half of the area of rain and snow, the prevalent direction of the winds was from the S.E. For some distance beyond the boundary of the rain on the E., the winds inclined towards the S.E., while along the N.E. border of the United States the winds were generally from the S.W.; but they were light, and in some places changing to N.E.

On the evening of the 20th, beyond the meridian of Chicago, the winds everywhere blew from the N. or N.W. Throughout all the remaining part of the United States the winds blew from some southern quarter, and the prevalent direction was from a point a few degrees E. of S. On the morning of the 21st, on the W. side of the centre of the storm, the winds were generally from the W. and N.W., the prevalent direction being from a point a few degrees N. of W.; on the E. side of the centre of the storm, the winds were generally from the S. and S.E., the prevalent direction being from a point a little E. of S.

On the evening of the 21st, throughout the extreme western part of the United States, the winds were becoming less northerly than in the morning; but in the neighbourhood of the storm, on the W. side of its centre, the winds continued from the W. and N.W., the prevalent direction being about 30° N. of W.; while on the E. side of the centre the winds were from the S. and S.E.

Thus, during the entire period, within the area of rain and snow, the direction of the winds was uniform. In the rear of the storm the winds blew from the W., N.W., or N., the average direction being 30° N. of W.; and in the S.W. part of the United States the winds were somewhat more northerly than in the N.W. part of the country. In the front of the storm the winds generally blew from some southerly point; the average direction was 10° E. of S.; and in the S. part of the United States, the winds were quite as much easterly as in the N. part of the country.

Thus Professor Loomis shows that along a meridian line of at least 1200 miles there was, on the W. side, a violent current setting from a point 30° N. of W.; and on the E. side, in close proximity, a strong current setting from a point 10° E. of S. These two currents blew with great violence for at least 48 hours, in directions inclined to each other 130° in the southern half of this storm.

The observations, as far as they go, indicate a decided crowding of the winds towards the centre of the storm, and also some tendency to circulate around the centre, in a direction contrary to the motion of the hands of a watch; but this storm was so much elongated that the direction of the winds cannot be even approximately represented by circles whose centre is at the point of greatest barometric depression.

Professor Loomis is of opinion that this storm commenced not far to the W. of the Mississippi River, and was caused by a high barometer along the eastern part of the United States, producing an easterly wind which was opposed by the normal W. wind. The E. wind was thrown upwards, and the condensation of the aqueous vapour brought about the observed phenomena. He imagines that the cold wind, which succeeded, came from the upper stratum of the atmosphere, and that the upper stratum of the atmosphere, when brought down to the level of the sea, is generally colder than the average temperature of the earth's surface: a part of the effect may perhaps be attributed to a transfer of air from a higher to a lower latitude.

European Storm of December 21–28, 1836.—From the records kept at 47 stations in Europe, a series of eight meteorological charts have been given by Professor Loomis, for each day at noon,—the only difference from the American series being, that the lines of isobarometric pressure are given for each quarter of an inch.

Observations of the Barometer.—On the 21st of December the barometer was above its mean height, throughout the whole of Europe, except its north-eastern portion; and here the greatest observed depression was ·41 inch. On the 22nd, the depression of the barometer near the centre of Russia had increased to ½ an inch, and the area of low barometer had extended somewhat further towards the S. On the 23rd the area of low barometer had extended so as to cover nearly the whole of Europe, comprehending nearly the whole of France and more than half of Italy; while the area of ½ an inch depression below the mean formed an oval figure, whose longer diameter was 1750 miles, and its shorter diameter over 500 miles. On the 24th the area of low barometer covered all of Europe, except its extreme northern portion; and there are two areas of ½ an inch depression, one having its centre over Switzerland, and the other in central Russia. The former area was an oval 870 miles long and 560 broad, while the latter was 1330 miles long and 520 broad. On the 25th the Swiss area of ½ an inch barometric depression was 980 miles long and 830 broad; while the Russian area had travelled towards the N.E., and had nearly reached the eastern limit of Europe; the greatest depression, —·97 inch, was at Milan.

On the 26th the Swiss oval of ½ an inch depression had increased still further in its dimensions, being now 1150 miles long and 930 broad; while the Russian oval of ½ an inch depression had passed beyond the limits of Europe. On the 27th, at noon, the Swiss oval was 890 miles long and 400 miles broad. On the 28th the

area of ½ an inch depression had nearly disappeared, and the area of ¼ an inch depression had contracted very much in its dimensions.

The Swiss area of low barometer on the 24th probably had a different origin from that of the low barometer which prevailed throughout eastern Europe on the 23rd. The latter travelled towards the N.E. from December 23rd to December 25th, at the rate of about 40 miles per hour. The former probably originated in western Europe, and its centre remained nearly stationary for four entire days, viz. from noon of December 24th to noon of December 28th; and this centre was at no time more than 140 miles from Mont Blanc, in Switzerland, being uniformly a little S. of that mountain peak.

Observations of the Thermometer.—During most of the eight days the thermometer was below the mean; but on the 21st, throughout the whole of Europe, except the extreme northern and southern portions, the thermometer stood above the mean,—throughout a considerable part of European Russia, more than 10°, and at one station 35° above it. On the 22nd and 23rd the area of 10° above the mean had contracted considerably in its dimensions; while on the N. of Europe the thermometer had fallen 10° below the mean. On the 24th the line of mean temperature had moved somewhat to the southward; while the area of 10° below the mean included Norway, Sweden, and a considerable part of Northern Russia. On the 25th, throughout the whole of Europe except its south-eastern portion, the thermometer was below its mean height; and throughout most of Europe the thermometer stood from 10° to 20° below the mean. On the 26th, 27th, and 28th the area of low thermometer was somewhat further extended, covering the whole of Europe except a small portion on the S.E.; while throughout the principal part of Europe the thermometer stood more than 10° below the mean. It is remarkable that while, in the neighbourhood of Switzerland, from the 24th to the 28th of December the barometer stood from ½ an inch to 1 inch below its mean height, the thermometer in the same vicinity from the 25th to the 28th was from 10° to 20° below its mean height. On the 26th and 27th the region of greatest barometric depression coincided nearly with that of greatest thermometric depression.

Face of the Sky.—From the 21st to the 28th of December, throughout nearly the whole of Europe, the sky was constantly covered with clouds. On the 21st there was a small region of unclouded sky on the north-western part of Europe, and another on the extreme southern part. Thoughout nearly the whole of Russia, rain or snow was falling, but at a moderate rate; and throughout all the rest of Europe the sky was overcast, but without rain or snow. On the 22nd there still remained a small region of unclouded sky on both the northern and southern borders of Europe. The Russian area of rain and snow had moved somewhat to the southward; while a second area of rain covered most of England and Scotland, as also Holland and the North Sea. On the 23rd these two regions of rain and snow had united—thus

forming a continuous area of rain or snow, extending from Land's End to the Ural Mountains, a distance of at least 2800 miles, but its average breadth from N. to S. did not exceed 500 miles. At the same time snow was falling over a limited space about the Orkneys, on the N. of Scotland. On the 24th this long storm divided and formed two separate storms: while the eastern portion advanced towards the N.E., the other storm covered an area of about 1500 miles in diameter, its centre being over the eastern part of France. There was no longer any region of unclouded sky on the southern side of Europe, but only on the northern margin. On the 25th both storms occupied nearly the same position as on the preceding day. On the 26th the Russian storm had passed beyond the limits of Europe, or had disappeared entirely; while the great storm of Western Europe had broken up into three separate areas of rain or snow; and in the southern part of Russia there appeared a new area of snow. On the 27th, between the parallels of 50° and 56°, there was a continuous belt of snow extending from E. to W. a distance of 2000 miles, and a somewhat smaller area of rain and snow on the S. of Europe; while a new area of rain appeared in the neighbourhood of Iceland. On the 28th the phenomena were generally similar to those of the 27th; but the snow area of Central Europe was now only about 900 miles from E. to W., while a fourth area of snow appeared in Sweden. The storm-cloud might now be said to extend over the whole of Europe; but in many places this cloud was thin, and at three stations the sky was left entirely uncovered. The greatest precipitation was most probably in the northern part of Italy, though there was a great depth of snow in England. At Florence the depth of rain that fell in the eight days was 3·18 inches.

Direction of the Wind.—On the 21st the wind blew from the W. or S.W. throughout nearly every part of Europe, except near its southern border. In Italy, and even as far N. as Munich, the prevalent direction was from the N.E.; and in Southern France it was from the N.W. These winds coincide with the average direction for December. There was a storm in Russia, but the amount of vapour precipitated was small.

On the 22nd, over Great Britain the prevalent winds were from the W.; over France, Germany, and the northern part of Russia, from the N.W. In Southern Russia the winds were from the southerly quarter. A cold current now begins to press down from the N. over Sweden and Germany. The storm in Russia is now more decided, and its influence extends to the direction of the winds in the S. of Russia. On the 23rd, over the whole of Western Europe and Northern Russia northerly winds prevail; in S. Germany they are from W. and S.W. In Italy the directions are various. The cold current from the N. extends still further, and probably joins the trade-winds, thus continuing to the equator. In the neighbourhood of the Russian storm, the winds deviate more from their mean direction, and exhibit a tendency inward towards the area of least pressure.

On the 24th, throughout all the N.W. quarter of Europe and

most of Germany, the wind was from N.E.; in the southern part of France from N.W., and in Italy from the S. The winds in Western Europe had a tendency to circulate round a centre, and to crowd inwards towards that centre. This centre nearly coincides with that of least barometric pressure near Mont Blanc. In Western Europe the wind blew a gale. In Eastern Europe the winds had a tendency to circulate round the point of least pressure in Russia.

On the 25th, throughout a circle of about 750 miles radius, there was the same tendency of the winds to circulate around a centre near Mont Blanc, with a more decided crowding inwards of the wind towards the area of least pressure; the winds were strong, in many places blowing a gale. In Eastern Europe there was an apparent tendency to circulate round the barometric minimum in Russia.

On the 26th, the direction of the winds was nearly the same as on the 25th in Western Europe: near the parallel of 50° easterly winds prevailed as far eastward as the Black Sea. In Italy the winds were generally from the S.W.; they tended towards the area of least pressure, and circulated round it. In Great Britain the winds were violent.

On the 27th, between the parallels of 49° and 55°, E. and N.E. winds still prevail as far E. as Central Russia; but the winds are less violent than on the 26th. There is a tendency to circulate around a central point, which is now E. of Mont Blanc. In Italy, the prevalent winds are from the W. and S.W.; while in Austria they are from the S.

On the 28th, between the parallels of 46° and 55°, N. and N.E. winds prevail as far E. as Russia, and there is still a marked tendency of the winds inward towards the point of barometric minimum, which is situated over Northern Italy.

Origin of the Storm.—The storm appears to have originated in Western Europe. On the 21st, throughout Europe, the winds blew in their normal direction; but in Iceland the barometer was 0·69 inch above the mean. On the 22nd the barometer in Iceland was 1·13 inch above the mean; and in North-western Europe it was high. This caused a flow of air towards Central and Southern Europe, where the pressure was less: the northerly wind was cold, and forced up the W. wind, which prevailed as an upper current; its vapour was condensed, and fell in rain in England and Scotland on the 22nd. On the 23rd, the barometer in Iceland stood 1·33 inch above the mean, and the W. wind was entirely displaced by the northerly current; the vapour in the W. wind was condensed by the cold of elevation, and rain fell in France.

On the 24th, the barometer in Iceland was still an inch above the mean; the high barometer extended over Sweden, and the force of the wind blowing towards Central Europe was much greater. N. of latitude 46° the temperature fell considerably; the vapour was precipitated in the form of snow. The heat liberated by this condensation of vapour expanded the upper stratum of air, causing it to flow off in every direction; and in Switzerland the effect of this was a barometric pressure $\frac{3}{4}$ of an inch below the

mean. The wind tended inwards towards this point, and, in pressing down from the N., crossed parallels of latitude whose diurnal motion eastward was greater than its own; it therefore had a relative motion westward. Hence, on the northerly border of the storm, the N. became a N.E. wind; and, for a like reason, on the southern border of the storm, the southerly wind became a S.W. wind.

A portion of the air, which flowed off from the region of low barometer, probably spread northwards, and increased the pressure in the North of Europe, adding new energy to the primary origin of the storm.

On the 25th, the phenomena of the storm in Western Europe were nearly the same as on the 24th; the barometer near the centre of the storm was still lower, being about 1 inch below the mean. The line of $\frac{1}{2}$-inch pressure above the mean in Northern Europe had advanced steadily southward since the commencement of the storm. In North Italy, the barometer was 1 inch *below* the mean; at Christiania, in Norway, it was $\frac{4}{8}$ths of an inch above the mean.

On the 26th, throughout Western Europe, the phenomena are nearly the same as on the 25th; but the action of the wind is less uniform: in some places, the rain and snow are as violent as they were; in others they have entirely ceased.

On the 27th, the phenomena are similar, but the storm is less violent; the greatest depression of the barometer scarcely amounts to $\frac{2}{3}$rds of an inch. This diminution of violence is probably due to the general prevalence of the cold current from the N., and the diminution of the westerly wind from the ocean, which furnished most of the vapour of precipitation.

On the 28th, the same causes operated with an energy still further impaired; and after the 28th they grew still feebler, until at length they disappeared entirely.

Comparison of the Lines of Barometric and Thermometric Oscillation.—In the storm of December 25th, throughout nearly all of Western Europe the thermometer was uniformly about 10° below the average; yet the barometer at Christiania was $\frac{4}{8}$ths of an inch above, and in North Italy 1 inch below its mean height. Hence Professor Loomis infers that the change of temperature at the earth's surface is not one of the principal causes of barometric fluctuations. While in North Italy the barometer was an inch below the mean, the thermometer at the earth's surface scarcely anywhere rose as much as 5° above the mean. Yet heat is always liberated when vapour is condensed; therefore he infers that this condensation took place at an elevation considerably above the earth's surface—at an elevation greater than that of St. Bernard (8000 feet), where there was a fall of snow, but no rise of the thermometer. The cause which produced the fall of the barometer in Switzerland operated at an elevation of more than 8000 feet above the sea; for at St. Bernard the oscillation of the barometer was as great as it was at the level of the sea.

On the 21st of December, in Russia, the area over which the

thermometer was 10° above the mean corresponded tolerably well with the area of snow and rain, but was a little displaced, overlapping on the S.E. side, and falling short on the N.W. side. A similar remark is applicable to December 22nd.

On the 23rd, throughout the whole of Europe, the area over which the thermometer stood above its mean height exhibited nearly the same form as the area of rain and snow, but was displaced towards the S., overlapping on the S. side, and falling short on the N. side. A similar remark is applicable to the 24th, at least as far as respects the Russian part of the storm.

Professor Loomis explains these facts thus:—In a great storm of rain and snow, when vapour is condensed, heat is liberated, which raises the temperature of the surrounding air above its mean height. This heated air is frequently wafted off by an upper current; and the heat of the upper stratum is partially communicated to the lower stratum, so that the area of high thermometer no longer corresponds with the area of rain and snow. The displacement of the one surface, as compared with the other, indicates the direction of this controlling upper current. From the 21st to the 24th of December, 1836, this upper current in Europe appears to have been from the N.W.

The fall of the barometer in great storms is not the effect of centrifugal force.

For the centrifugal force of a body revolving in a circle is to its weight as V^2 to 32 R, where V represents the velocity in feet per second, and R is the radius of the circle expressed in feet. Now, on the 25th of December the barometer fell $\frac{1}{2}$ an inch below its mean height, throughout a circle whose radius was 400 miles. Supposing the velocity of the wind 70 miles per hour, or 100 feet per second. Then—

$$C : W :: 10000 : 32 \times 400 \times 5280, \text{ or } C : W :: 1 : 6758;$$

that is, the centrifugal force is less than $\frac{1}{6000}$ part of the weight of the revolving body—a force which would depress the barometer less than $\frac{1}{200}$th of an inch; whereas the barometer fell $\frac{1}{2}$ an inch below its mean height.

The European storm of December 25, 1836, had no connexion with the American storm of December 20th. The American storm, from its rate of progress, could not have reached England before the 27th; whereas the European storm had become fully organized on the 23rd. The European storm evidently originated in Europe; and the American storm gradually wasted away, and probably could not be traced beyond the middle of the Atlantic.

By comparing the European storm of December 25, 1836, with the American storm of December 20, 1836, and also the storms of February 4 and 16, 1842 (see 'Transactions of the American Philosophical Society,' vol. ix. pp. 161–184), Professor Loomis has arrived at the following generalizations, which are here given verbatim, some of which are substantially the same as those given by

Mr. Espy in his fourth 'Meteorological Report,' though he states that several of Mr. Espy's conclusions are only true when applied to American storms.

"1. The area covered by a violent storm of rain or snow is sometimes nearly circular in form; sometimes its form is very much elongated or elliptical, its length being two or three times its breadth; and frequently its form is very irregular. In the winter-storms of the United States, the N. and S. diameter is generally very much greater than the E. and W. diameter.

"2. When storms are circular in form, the area of rain or snow is sometimes 1500 miles in diameter; when their form is elliptical, the area of rain or snow is sometimes 1000 miles wide, and 2000 or 3000 miles long.

"3. Violent storms sometimes remain sensibly stationary for four or five days; but generally the centre of a storm has a progressive movement along the earth's surface. The rate of this progress has been observed to vary from zero to 44 miles per hour. From our limited number of observations, it seems probable that American storms travel more rapidly than European storms.

"4. Within the limits of prevalent westerly winds, when violent storms advance with considerable rapidity, the direction of progress is always from W. to E. This direction is not absolutely uniform, but has been observed to vary from about due E. to N. 54° E.

"5. Great storms of rain and snow are accompanied by a depression of the barometer near the centre of the storm, and a rise of the barometer near the margin; but this rise is not generally uniform along the entire margin.

"6. The depression of the barometer at the centre of a storm sometimes amounts to more than an inch *below* the mean height; and the rise along some portion of the margin sometimes amounts to more than an inch *above* the mean height.

"7. Winter storms commence gradually, and generally attain their greatest violence only after a lapse of several days; after a time their violence gradually diminishes, and at length they disappear entirely. This succession of changes requires a period of several days, sometimes one or two weeks, and possibly even longer. Sometimes all these changes are experienced over the same country; that is, the storm makes no progress from place to place. More commonly, however, the storm travels along the earth's surface; and although the same storm may continue for one or two weeks, or even longer, its duration at any one place may not exceed one or two days.

"8. For several hundred miles on each side of the centre of a violent storm, the wind inclines inwards towards the area of least pressure, and at the same time circulates around the centre in a direction contrary to the motion of the hands of a watch.

"9. In Europe, as well as in the United States, on the N. side of a great storm the prevalent winds are from the N.E., while on the S. side they are from the S.W.

"10. The force of the wind is proportional to the magnitude and

suddenness of the depression of the barometer; but very near the centre of a violent storm there is often a calm.

"11. On the borders of the storm, near the line of maximum pressure, the wind has but little force, and tends outwards from the line of greatest pressure.

"12. The wind uniformly tends from an area of high barometer towards an area of low barometer; and this is probably the most important law regulating the movement of the wind.

"13. In a great storm, the centre of the area of high thermometer frequently does not coincide with that of the area of low barometer, or with the centre of the area of rain and snow. In the United States, on the N.E. side of a storm, at a distance of over 500 miles from the area of rain and snow, the thermometer sometimes rises even 20° above its mean height.

"14. The storms of Europe are very much modified, and sometimes in a great measure controlled, by the Alps of Switzerland. By the interposition of these mountains, the air which sweeps over them is forced up to a great height, where it is suddenly cooled; its vapour is condensed; heat is accordingly liberated, by which the surrounding air is expanded, and rises above the usual limit of the atmosphere. It thence flows off laterally, leaving a diminished pressure beneath the cloud; that is, the barometer shows a diminished pressure in the neighbourhood of the mountain. The mountain thus becomes the centre of a great storm, and the storm may continue stationary for several days, being apparently held in its place by the action of the mountain."

VI. *Magnetic Storms and Earth-Currents.*

FISHER—'Report of the British Association for 1845,' pp. 22–25. June 1845.
STEWART—'Philosophical Transactions of the Royal Society,' vol. cli. part ii. pp. 423–430. November 21, 1861 (June 28).
LAMONT—'Archives des Sciences Physiques,' nouvelle période, tom. xii. pp. 350–357. 1861, December 20 (1861, October 30).
DE LA RIVE—Ibid. tom. xii. pp. 358–368. 1861, December 20.
SECCHI—Ibid. tom. xii. pp. 369–373. 1861, December 20.

The relation between the currents of electricity that are found moving in the mass of the earth and the phenomena of terrestrial magnetism promises to become an important feature in meteorological science. Several papers on this subject have come to hand since the first Number of the 'Proceedings' went to press. Before adverting to these papers, and without pretending to go back to all that may have been previously published having a bearing on these questions, it may be proper to take notice of a report laid before the British Association by the Rev. G. Fisher, M.A., F.R.S., and of which an Abstract is published.

Mr. Fisher accompanied Captain Parry's Second Expedition to the Polar regions, as astronomer to the expedition. He says,

"The principal displays of the aurora occur in the vicinity of the edge or margin of the Frozen Sea;" and that "it is an electrical phenomenon, and arises from the positive electricity developed by the congelation of these [humid] vapours, and the consequent induced negative electricity of the upper and surrounding portions of dry atmosphere. It is the accompanying indication of the restoration of the electrical equilibrium, which equilibrium is restored by the intervention and conducting power of minute frozen particles, which particles are rendered luminous by the transmission of the electricity, and thereby give rise to the various appearances of the phenomena." In early winter, before the sea was frozen over, he observed that the aurora had a diffused character, and extended through the zenith in all directions. As winter advanced, and the edge of the ice became more remote, "so the aurora diminished in splendour, assumed a low-arch appearance, and was seen only in the direction of *open waters*;" and "that its usual height above the surface of the earth is very inconsiderable in high latitudes." "The sudden deposition of extremely minute frozen particles, when auroral displays took place near to the zenith, was several times observed by the author," as well as by others elsewhere. He refers to Professor Joslyn, who, in 'Silliman's Journal' for October 1838, states, among other conditions, "that it requires for its development a cold adequate to the crystallization of aqueous vapours; that crystals of snow, more minute and simple than those which produce halos, are always present in the atmosphere above the region of ordinary clouds during the appearance of this meteor." Mr. Fisher considers "that perhaps the strongest proof of the important agency of these particles in an auroral display is to be derived from the fact, that the auroral light can be distinctly traced to those localities where humid vapours are known to be undergoing rapid congelation, and where such particles must in consequence abound, and that, in the usual arch-formation, whatever may be the *nature* of the light, yet the auroral fringe clearly arises from the illumination of the frozen particles which are formed from the extreme portion of the vapours, being under the influence of the cold atmosphere immediately above them."

He had obtained sufficient evidence of the direction of the situation of the *open water*, from the dark masses of vapours known as "sea-blink," and from the information of the Esquimaux, which was confirmed by certain observations of refraction of the star Sirius. The upper limit of the auroral arch was generally dense and dark, as if charged with humidity; the lower, being nearer the water-surface, was warmer, and transparent, so that stars were visible through it.

When ice breaks up by the action of spring-tides, and water is suddenly exposed, a difference of more than 70° Fahr. is often found between this water-surface and the atmosphere immediately over it; so that the latter becomes immediately impregnated with the extremely minute frozen particles known as "frost-smoke." And the author conceives that "the alternate opening and closing of

the ice, by which means different portions of vapours are detached from the surface of the sea consecutively, give rise to the appearance of different concentric arches of aurora." He considers that the upper and colder portion of the atmosphere acquires an opposite state of electricity to the lower; and that while thunder and lightning are the indications of the restoration of equilibrium in other regions, "the aurora points out the mode by which the same end is silently effected in the cloudless atmosphere of a polar winter, and other places where it occasionally occurs, by the interposition and conducting power of the frozen particles that are there and then formed;" and that vertical streamers are columns of these particles in the act of restoring equilibrium between higher and lower strata; that when the particles of these columns are distributed by the winds, diffused aurora is produced, "which is usually terminated by a deposition of the particles when they have performed their office." Low temperatures and humidity are, in his opinion, the conditions required for the production of aurora; and hence "the winter limits of the Frozen Sea, which extend from the American to the northern coast of Europe, will be most favourable to the production of the aurora, from the circumstance of there being there the greatest supply of humidity;" and it is a fact that "gales of wind from the south, which bring to the ice portions of atmosphere saturated with moisture from seaweed, most frequently accompany these auroral displays." He infers that the auroral zones will not approach nearer to the poles than the margin of fixed ice, for lack of humidity; and that hence their contours must approximate to that of the isothermal lines, which latter are known to accord with the magnetic curves. He identifies these zones with electric currents moving from E. to W., this direction being assumed to be due to the action of the sun. He thinks that, when electrical equilibrium is restored by an auroral display, the horizontal-force magnetometer indicates diminished action, and the declination increases from that part of the zone where the discharge occurs.

Mr. Stewart communicated to the Royal Society a paper "On the Great Magnetic Disturbance which extended from August 28 to September 7, 1859, as recorded by Photography at the Kew Observatory," and speaks of the interest of this display being enhanced by the fact that a large spot, attended with special phenomena, was observed on the sun during the storm—sun-spots being supposed to have an intimate relation to magnetic disturbances. He alludes to the aurora in this case having been manifested in places where its appearance is rare—even at so low a latitude as that of Cuba; to the almost universal interruption of telegraphic signals by the intrusion of earth-currents; and especially to the description given by Professor Loomis. "There appear to have been two great displays, each commencing at nearly the same absolute time throughout the globe—the first in the evening of the 28th of August, and the second in the early morning of the 2nd of September, Greenwich time." The dis-

turbances of the magnetometer were self-recorded photographically at Kew. Reduced drawings accompany his paper, on the scale of $\frac{3}{10}$ths of an inch to an hour. There is a serrated appearance in the early parts of the curves, which the author states always precedes and follows great disturbances. Normal lines, calculated by General Sabine, showing what the curve would have been, had there been no abnormal disturbance, are given.

There are two distinct, well-marked disturbances, which correspond in time with the auroral displays. The disturbing force was of a pulsatory character, the minute pulsations varying "from half a minute, or the smallest observable portion of time, up to four or five minutes;" which "agrees well with the nature of its action on telegraphic wires, in which observers have noticed that the polarity of the current changes very frequently."

Besides these small and rapid pulsations, Mr. Stewart recognizes, "for all the elements, pulsations in the disturbing force, which have a period of 40 to 50 minutes;" which are "of a very violent character in the case of the declination." The first or smaller of these waves is superimposed on the second or larger. "But, in addition to these, there is a still more remarkable period, which this great disturbance seems to have accomplished for all the elements in about six hours from its commencement, after which it started anew in the same direction as at first, to accomplish another period or grand wave, which lasted about the same time." As the curves of all the elements went *beyond* the sensitive paper, the *full* value of the greatest departures are not known. These characteristics were common to the two great disturbances constituting the entire storm.

During the progress of the storm an appearance of peculiar interest was seen on the surface of the sun. Mr. Carrington was making one of his daily observations on sun-spots, at Red Hill, on September 1, a little before noon, "when within the area of the great north group [of spots] (the size of which had previously excited general remark) two patches of intensely bright and white light broke out;" and their "brilliancy was fully equal to that of direct sunlight." Mr. Carrington adds, "Seeing the outburst to be very rapidly on the increase, and being somewhat flurried by the surprise, I hastily ran to call some one to witness the exhibition with me, and on returning within 60 seconds, was mortified to find that it was already much changed and enfeebled." Contrary to his expectations, the configuration and details of the group of spots was not changed by this sudden conflagration, which had traversed 35,000 miles of the sun's surface in 5 minutes. Mr. Hodgson, another Fellow of the Royal Astronomical Society, chanced at the same moment to be observing the sun at Holloway, and was witness to similar phenomena. "On calling at the Kew Observatory a day or two afterwards, Mr. Carrington learned that, at the very moment when he had observed this phenomenon, the three magnetic elements at Kew were simultaneously disturbed;" so that "our luminary was taken *in the act*" of causing magnetic disturbance.

The author considers "auroral displays, earth-currents, and magnetic disturbances" to be "simultaneous effects, produced by the same cause." Referring to the six-hour cycle, three hours' decrease of the components of the earth's force, followed by three hours' increase, he says:—"Were this due to the direct action of an electric current, it would require that this current should have flowed in the same direction for six hours, or at least that it should have been so limited in direction as to influence the earth's magnetism at Kew in the same manner for about six hours." But Mr. C. V. Walker, in his paper on this same storm, has shown that "the 1-minute currents are most in number; then in order the 2-minute, 3-minute, 4-minute, ½-minute, and 5-minute." And "it seems impossible" to Mr. Stewart "that any combination of such currents of short period and rapid reversal can account for the six hours' march of the earth's force at Kew, and equally impossible not to associate these currents of small period with the rapid and minute change which gives a pulsatory character to the disturbing force and a serrated appearance to the curves."

He has reason to suppose that the primary disturbing force resides in the sun; that the earth may be viewed as the iron core of an electro-magnet, separated by the lower strata of the atmosphere, or insulating medium, from the upper strata, or conducting medium; that if the primary current in the sun increases or diminishes, it will not reverse the magnetic state in the earth, but merely change it in amount; but that a change in the primary current will produce a secondary current,—1st, along the surface of the earth; 2nd, along the upper strata of the atmosphere: "and this discharge will be in one direction for an increase, and in the opposite direction for a diminution of the primary current." So that he infers disturbances "to be due to the absolute amount of the primary current, and auroras and earth-currents to the rapidity with which this current changes. He hopes that, ere long, "something more definite may be known with regard to the exact relation that subsists between" sun-spots and disturbances.

Dr. Lamont has written a letter to Professor De la Rive, dated 1861, Oct. 30, "On the Earth-current and its Relation to the Magnetism of the Earth," in reply to a request "that he would kindly give him further details upon the observations that had led him to his discovery" "of terrestrial currents." Dr. Lamont is about to publish a memoir containing a full statement of the experiments of which he here gives a sketch. He has, in the neighbourhood of the Observatory at Munich, placed at the surface of the earth and under the earth not less than twenty-eight plates of different metals, and at different depths. His galvanometer, he says, "does not indicate the earth-current itself, but only the *undulations of the earth-current*, or the momentary variations that it undergoes." He attributes his failing to obtain the full effects of the earth-current to "the fact that the buried plates and the telegraph wires are constantly exposed to disturbing influences, particularly to heat and oxidation." He had noticed that the

motion of the galvanometers corresponded, as to time, with that of the magnetometers, but not in degree; and he has subsequently concluded "that it is only during a rapid increase or decrease of the earth-current, and, so to speak, in consequence of electric affluence, that the needles of the galvanometers are affected; but immediately the increase or decrease ceases, the earth-current continuing to be propagated with a uniform intensity, and the magnetic instruments remaining in the same position, the galvanometers gradually return a little backward."

Dr. Lamont passed an artificial current through a tract of land; he thrust a pair of plates into the route of the current, connected with a galvanometer; and he noticed that the movement of the needle, "*at the end of a very short time, is considerably reduced.*" He does not attribute this change to polarization; but thinks "that when two routes are presented to a galvanic current—a shorter metal conductor of *limited section*, and the earth a longer conductor of *unlimited section*—the current passes first by the former and then directs itself into the latter" by penetrating into the lower strata; which, however, does not interfere with its general action upon magnetometers. In a note, Professor De la Rive explains that this change of value is due to the polarization of the buried plates. Dr. Lamont, however, considers this "one of the most important special characteristics of the earth-current;" and that "the constant influence is so feeble" that he doubts whether it can be observed, unless by plates buried deeply and "the establishment of a subterranean station for observations, so as to escape completely the disturbing action of heat and oxidation." He finds that the *undulations* are less, according as the plates are buried more deeply; "at 12 feet they lose quite the half of their intensity." He has only partially formed an opinion as to "the *direction* in which the earth-current is propagated." He has a line of observation on the magnetic meridian, and another at right angles: from observations on these lines, he concludes "that the direction of the principal current is perpendicular to the astronomical meridian," and this he calls "*the equatorial current*;" but he says that "a current in the meridian—*a polar current*—which would be comparable to the equatorial current, does not exist, or if it exists at all, it is so insignificant that it cannot be appreciated by means of my instruments." He also considers "that the *direct* influence of an earth-current which is moving along at the surface cannot give rise to the diurnal variations of terrestrial magnetism; because a current of this kind would not affect the vertical intensity." He suggests whether the *regular part* of magnetic variation may not be due to solar influence, and "only *the irregular part* to the earth-current." He thinks "that the electricity of tension, which is diffused throughout the surface of the globe, is the basis of the earth-current;" and "that the earth-current circulates *at the surface*, and that the variations set out *from the surface*."

Professor De la Rive has given an "Analysis of the Researches

of Mr. C. V. Walker upon Earth-currents," which were referred to in the 'Proceedings of the British Meteorological Society,' No. 1, p. 73. He says, "M. Lamont's observations establish beyond doubt the existence of earth-currents, and their connexion with the variations of the elements of terrestrial magnetism;" and that "earth-currents exist in a permanent manner, and are not simply transitory phenomena connected with certain electric and magnetic disturbances." He gives a *résumé* of Mr. Walker's paper, "deferring to a future number of the 'Archives' the examination of the conclusions that may be deduced from it, and the exposition of some other works of the same kind recently done."

Referring to the very marked coincidence shown in certain cases, by Mr. Walker, to have existed between the Greenwich or Kew photograms and the curves expressing the variations in direction or in value of earth-currents, he adds:—"But these first results are as yet only a ground of encouragement to pursue this class of researches. It would be very desirable that observatories in which the determinations are made of the magnetic elements and of their divers variations should be furnished with the necessary apparatus* for making, simultaneously with the magnetic observations, those relating to earth-currents, in a complete and exact manner, in order thus to be able to follow comparatively the march of these two great classes of terrestrial phenomena." He refers, in a note, to what M. Lamont has done in this respect.

Adverting to his own paper published at the end of the year 1859, in reference to the great disturbances that took place in August and September of that year, and which attracted attention in their various developments in almost every region of the earth, Professor De la Rive says, "In opposition to my theory, Mr. Walker shows that the earth-currents collected during the presence of an aurora borealis are directed as much from S. to N. as from N. to S.; whilst, according to my theory, they ought to be directed only from N. to S. He does not think that the currents from S. to N. can be explained, as I have endeavoured to explain them, by the polarization of the metal electrodes that are placed in the ground in order to derive a part of the earth-current. I am convinced, contrary to the opinion of Mr. Walker, that the polarization of the electrodes does play a very great part in collecting earth-currents; but I admit that it might equally well explain the currents directed from N. to S., as those which travel from S. to N. I am prepared, then, to admit that, in point of fact, there are earth-currents travelling equally in both directions; but this fact in no degree shakes the principle of my theory, namely, that auroræ boreales are due to electric discharges which take place near the poles of the terrestrial globe, and that the earth-currents which accompany the appearance of aurora borealis arise from the same cause. I shall endeavour to prove this in a forthcoming article, which will be essentially devoted to aurora borealis, and to

* In No. 1 of the 'Proceedings of the British Meteorological Society," at p. 73, is a notice of the important arrangements that are at this moment being carried out by the Astronomer-Royal, in connexion with the Greenwich Observatory.

the connexion of this phenomenon with that of the manifestation of electric earth-currents and magnetic disturbances. I will show how both the observations of M. Lamont, as well as those of M. Secchi and those of Mr. Walker, and of all the very numerous observers, especially in America, who are turning their attention to this class of phenomena, lead to confirming, as I have pointed out in my *Traité d'Electricité*, the existence of two very distinct causes,—the one regular and permanent, which produces terrestrial magnetism, and the regular variations to which it is subject; the other variable and accidental, which brings about the irregular disturbances that are presented by the magnetic elements, and the atmospheric effects (auroræ boreales and others) which accompany these disturbances."

Father Secchi has published a second memoir on "The Relations that exist between Meteorological Phenomena and the Variations of Terrestrial Magnetism," of which Professor De la Rive gives a *résumé*. The author reports the various meteorological circumstances which accompany the aurora and favour its appearance, especially in the polar regions. He dwells specially on the part played by "the small icy particles suspended in the elevated regions of the air,—an influence which has already been made manifest by the action exercised by cirri upon the bifilar magnetometer." M. De la Rive thinks that he was himself the first to set forth the importance of this fact; and that he had cited very many cases proving that the appearance of aurora is connected with the presence of these icy particles—a presence indicated either by halos or by other meteorological conditions. Secchi concludes:—"1st. That the character of winter clouds in the polar regions is different from that of the ordinary clouds, and that the appearance of these latter clouds at the poles is a signal, the harbinger of the fine season and of humidity, whilst the auroræ then disappear. 2nd. That the aurora does not appear unless when the weather is humid, and that its appearance is very rare during the periods of squalls or of variable weather, during which the winds are naturally a little warm, as well as during mild winters. 3rd. That even when the sky in the polar regions appears limpid, it is nevertheless filled with small icy particles, which has been proved, according to Capt. Parry, both by the fact that stars seen by the telescope are surrounded by an aureole, and because there is always a fall of small icy particles. 4th. That Franklin places in the list of circumstances most favourable for aurora a sky slightly covered and a very sensible cold, auroræ being always very rare if the temperature is above 0°. The fact that the *aurora is contemporary with a very dry atmosphere, the temperature of which is below* 0°, *containing small icy particles*, may be considered beyond all doubt, and more than proved."

M. Secchi concludes that "*the height of the aurora does not differ from that of the clouds and that of the haze of icy particles, which is sometimes very low*," and that we may admit a correspondence between the limit of auroræ and that where the annual

isothermal descends below 0°. He concludes:—1st, that aurora is an atmospheric phenomenon; 2nd, that it prevails when the atmosphere is charged with icy particles; 3rd, that its light is electric; 4th, that friction of icy particles by the wind, transition from vapour to solid, and electric induction are so many causes in explanation of the production of electricity as associated with aurora; 5th, that phenomena of this kind in icy clouds in temperate regions may, like auroræ at the poles, have some influence over magnetic instruments by virtue of the electricity developed,—phosphorescent clouds, which give rise to magnetic disturbance, being due to phenomena of this class; 6th, that aurora confirms the relations already established by the author between meteorological changes and those of terrestrial magnetism.

Professor De la Rive adds to the summary of which the above is the substance a few notes of his own. He states that in 1849, and subsequently, he had established many of the conclusions arrived at by Father Secchi, "particularly on the height of auroræ boreales, and on the simultaneousness between their appearance and the presence of small icy particles in the atmosphere, whence I had concluded, as he has done, that the aurora borealis is a phenomenon essentially atmospheric and electrical." He is glad to see astronomers arrive at this conclusion, to which they had been long averse. He does not, however, follow M. Secchi in his views of the origin of auroral electricity, believing that electricity has never been artificially developed by the friction of icy particles against each other, or by the mere change of condition of a body, especially of water. And, with regard to induction, this view increases the difficulty, because the origin of the electricity that causes the induction is to be accounted for. He thinks the origin is to be sought beneath the surface of the earth, and in the aqueous vapours acting as vehicles to convey positive electricity from the ground into the higher regions of the air. He adds that "Father Secchi has just pointed out a new and very remarkable connexion between the variations of atmospheric electricity and those of the bifilar magnetometers," in 'Les Comptes Rendus' of November 18, 1861.

The most salient point, forcing itself on the notice of M. De la Rive, in Father Secchi's recent memoirs "is the almost peremptory manner in which he establishes the necessity, for the appearance of the aurora, of the presence of clouds of ice, or of the suspension of small icy needles in the atmosphere,—a condition which explains the singular action upon the magnetized needle of certain clouds which are cirri formed of small icy particles, and which itself finds a confirmation in the important circumstance pointed out by Father Secchi, that the line of auroræ almost coincides with the zero isothermal."

On February 13, 1862, Mr. C. V. Walker communicated to the Royal Society a paper "On Magnetic Calms and Earth-Currents." The substance of this paper, when the Abstract is published, will be given in the 'Proceedings of the British Meteorological Society.'

[*Price Two Shillings.*]

Vol. I.] [No. 3.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

1862, MARCH 19.

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NOTICE TO MEMBERS.

*** The Report for the year ending 1861, June 12, is nearly ready.

[*Advertisements continued on the third page.*

BRITISH METEOROLOGICAL SOCIETY.

THIS Society was established in the year 1850, for the encouragement and promotion of Meteorological Science.

It consists of Members and Honorary Members.

Every person desirous of admission into the Society must be recommended by at least Three Members, of whom one must certify to his personal knowledge of such Candidate.

Candidates may be proposed at a Council Meeting; but the ballot must take place at an Ordinary Meeting. One Council or Ordinary Meeting must intervene between the nomination and the day of Election.

There is no Admission Fee. The Annual Contribution is £1; due on January 1. The Composition Fee is £10.

Persons eminent in Meteorological Science, not permanently residing in this country, are eligible as Honorary Members.

The Council of the Institution of Civil Engineers allow the Society to hold their Meetings at the Institution, No. 25 Great George Street, Westminster, S.W.; and to receive letters there.

Four Ordinary Meetings are held during the Session, which commences in October and terminates in June, at which Members can introduce their friends.

Papers accepted for reading at the Ordinary Meetings are published entire or in Abstract in the 'Proceedings' of the Society, which are issued as soon as possible after each Meeting, *and of which a copy is sent to every Member of the Society*. The 'Proceedings' also contain Notices of Books and Memoirs, descriptions of New Instruments, and other Meteorological News.

Daily observations are made, for the most part by Members of the Society, at about 60 different stations, which are forwarded monthly to one of the Secretaries, by whom each reading is examined and collated with readings made in adjacent stations. Their means are taken; and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of each 'Quarterly Meteorological Report' *is sent free to every Member of the Society*.

Copies of printed results of Meteorological Observations or Papers are from time to time received by the Society for distribution; and *are forwarded free to Members*.

The 'Proceedings' of the Society are published and sold by Taylor and Francis, Red Lion Court, Fleet Street, E.C.

The Society possess a Library, which is available to Members. The President, N. Beardmore, Esq., has kindly received it in his rooms, 30 Great George Street.

1862, March 1.

JAMES GLAISHER, F.R.S.,
Dartmouth Place, Blackheath, S.E.
CHARLES V. WALKER, F.R.S.,
Fernside, Redhill.
} *Secretaries*.

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Rev. R. Tyas, Vicarage, Frodsham;
Wm. O. Wildman Whitehouse, Esq., M.R.I., 4 Victoria Street, Westminster;
Nicholas Whitley, Esq., C.E., Truro;
were balloted for and duly elected Members of the Society.

XIII. *On the Correlation of the Daily Values for Atmospheric Pressure, as calculated respectively for Newport and for Greenwich.* By John C. Bloxam, Esq., M.R.C.S.

Mr. Glaisher having published Tables of barometric values, founded on eighteen consecutive years of observation, I have thought that it would be interesting to meteorologists to have these values placed in correlation with the corresponding values as they are given in my 'Meteorology of Newport,' which are founded on the first sixteen of Mr. Glaisher's eighteen years. I was soon stopped in my task by finding that Mr. Glaisher's adopted daily mean values did not harmonize with my own, in consequence of different methods having been used by us, respectively, for computing the average mean value pertaining to each day in the year. This difficulty was met by reducing the mean values in Mr. Glaisher's Table XIII. (printed in the Annual Report of the Society, 1859–60, p. 29), by the same method that I had already used for the reduction of my

own mean daily values to constant average mean daily values or adopted means. Mr. Glaisher had recourse to the ordinary method by ordinates and abscissæ; and I have used a simple arithmetical process, which I believe to be by far the more eligible of the two for the purpose in view. The daily values as obtained by this process are materially different from those obtained by Mr. Glaisher by the ordinary method, and they prove to be very much in harmony with those I had previously published for Newport. It seems to be desirable to determine the respective merits of the two methods; but as a discussion on this point would be out of place here, I propose to deal with it in the paper which follows this.

The annual mean for atmospheric pressure at Newport, as reduced to the sea-level, is 29·970 in., and at Greenwich (allowing ·182 in. for reduction to sea-level) it is 29·961 in.,—the difference being ·009; which is perhaps, as nearly as can be estimated, the difference belonging to the difference of latitudes. The maximum for the year at Newport is 30·143 in., that for Greenwich being 30·106 in.: this gives an absolute excess for Newport of ·037, and (allowing for latitude) a relative excess of ·028. The minimum at Newport is 29·821 in., that for Greenwich being 29·812 in.; and this makes the two relatively identical.

The dates on which the annual mean value occurs, successively, at Newport and Greenwich, respectively, are as follows:—

TABLE I. Dates of Means.

Newport.		Greenwich.	
January	4	January	5
February	8	February	10
March	17	March	17
April	17	April	18
„	22	„	25
May	25	May	26
June	14	June	14
July	20	July	20
„	30		
August	13	August	14
September	22	September	23
November	2	November	8
„	15	„	14
December	5	December	8
„	13		
„	18		

The correspondence is here very marked; but there are some exceptions. On July 20, the line of progression for Newport does not actually touch the mean line, but descends to ·002 in. above it, and then rises for a few days to descend again and cross the line on July 30; whilst at Greenwich it crosses the line on the 20th, and continues to descend, and reaches a point ·009 in. below the mean on the 30th. It is at this period of the year that the two yearly series of values differ the most from one another. On December 13 the line of progression for Newport crosses the mean line in its descent, to cross it again in ascent on the 18th; whilst at Greenwich it descends to a minimum on the 18th, which is ·016 in. above the mean.

The maximum occurs at Newport on September 3; and at Greenwich it occurs on the same day. The minimum occurs at Newport on October 4; and at Greenwich it occurs on October 5. The maximum which comes next in value to that of September 3, at Newport, is on March 8; and at Greenwich it is on March 8. The minimum which comes next in value to that of October 4, at Newport, is on November 23 and 24; and at Greenwich also it falls on November 23 and 24.

The following Table gives the successive periods in which the pressure at Greenwich is either above or below that at Newport. The algebraic signs belong to the Greenwich values as compared with the Newport values, and, with the figures following them, show the mean differences for the respective periods.

Table II. Periods of Differences.

January 25	February 18	−·014
February 20	March 1	+·011
March 2	March 16	−·023
March 18	March 30	+·017
April 1	April 18	−·008
April 19	May 13	+·006
May 15	June 1	−·005
June 2	June 5	+·001
June 6	June 14	−·003
June 15	June 29	+·008
June 30	September 12	−·009
September 13	October 4	+·013
October 5	October 9	−·001
October 11	October 15	+·002
October 16	November 19	−·007
November 20	January 24	+·013

There is here one long period of Greenwich defect, viz., June 30 to September 12; and one long period of excess, viz., November 20 to January 24. There are two periods of marked

equality, viz., June 2 to June 14, with a defect of ·002; and October 5 to October 15, with a merely nominal excess.

There is a remarkable correspondence in the dates of the alternate maxima and minima through the year. The following Table gives the dates, the values, and the differences for these particulars; the values given for Greenwich being such as belong to the sea-level.

TABLE III. Successive Maxima and Minima.

Newport.		Greenwich.		Difference.
January 10, 11	29·901	January 10, 11	29·912	+·011
„ 24, 25	29·952	„ 19, 20, 21	29·951	−·001
„ 28	29·950	„ 28, 29, 30	29·929	−·021
February 16, 17	30·008	February 17, 18	29·992	−·016
„ 24	29·973	„ 23, 24	29·979	+·006
March 8	30·125	March 7, 8	30·081	−·044
„ 24, 25, 26	29·900	„ 26	29·909	+·009
„ 29, 30	29·909	„ 28	29·910	+·001
April 7	29·886	April 8	29·868	−·018
„ 18, 19	29·974	„ 20	29·969	−·005
May 6, 7	29·925	May 6, 7	29·928	+·003
„ 14	29·949	„ 13	29·941	−·008
„ 19, 20	29·939	„ 19, 20	29·925	−·014
June 1	30·026	June 2	30·017	−·009
„ 14, 15	29·971	„ 13, 14	29·961	−·010
		„ 24, 25, 26	29·995	+·002
July 4	30·004			−·019
„ 20	29·972	July 25	29·954	−·018
„ 27	29·978	„ 27	29·957	−·021
August 6	29·942	August 6	29·932	−·010
September 3	30·143	September 2, 3	30·106	−·037
October 4	29·821	October 5	29·812	−·009
„ 19, 20	29·912	„ 17, 18, 19, 20	29·899	−·013
„ 24	29·905	„ 23, 24	29·896	−·009
November 9	30·019	November 8, 9	29·997	−·022
„ 23, 24	29·850	„ 23, 24	29·850	·000
December 9	29·985	December 9, 10	30·000	+·015
„ 15, 16	29·967	„ 17, 18	29·977	+·010
„ 28	30·065	„ 28	30·056	−·009

The two highest values in the column of differences belong to the dates of the two greatest elevations in the year; the difference being as much as ·044 in. for March 8. The high maximum which occurs at Newport on March 8 is followed by a period of great depression; and this depression is less marked, as well as the previous elevation, at Greenwich. There are three occasions on which the convex curve rises higher at Greenwich than at Newport, two of these giving *together* an excess of ·003 only: on December 9 this excess amounts to ·015. There are five occasions on which the concave curve keeps higher at Greenwich than at Newport,—the mean difference for these five being ·008 in.: the two greatest differences

in this respect occur in December and January. On July 4 a maximum occurs at Newport, which is not found at Greenwich, the pressure being much the lowest at Greenwich.

The convex curves are, on the average, ·012 in. lower at Greenwich than at Newport,—·003 more than what is due to latitude. The concave curves are, on the average, ·005 in. lower at Greenwich than at Newport,—·004 less than what is due to latitude. The curves are therefore, on the whole, decidedly less salient at Greenwich than at Newport.

In order to discover the causes of the differences and the similarities between the two sites, we ought to have corresponding Tables of values for other meteorological particulars. There are some facts, however, which may now be referred to as tending to elucidate the matter. I find, by reference to Greenwich monthly values computed for the years 1841–56 (for which I am indebted to Mr. Glaisher), that the temperature is markedly in excess at Greenwich for the months of June and July, and that the dew-point is also in excess during the hotter months; and I find that the temperature begins to decline earlier in the year at Greenwich than it does at Newport. The most remarkable decrement in atmospheric pressure occurs between September 3 and October 4, —the pressure attaining its maximum on the former date, and its minimum on the latter date; and this minimum is cotemporaneous with a very rapid decline of temperature and a most abundant fall of rain at Newport. The excess of vapour at Greenwich and at higher latitudes, as compared with Newport, in June and July, and the earlier decrement of temperature in these localities, we may suppose bring about earlier deposition and, along with it, defective pressure during July and August, as compared with what the pressure is at Newport in these months; but the defective pressure is probably owing to low temperature and active deposition in the higher latitudes, much more than to these conditions as they may exist at Greenwich itself. I have shown, in my 'Meteorology of Newport,' that long-continued low temperature and deposition are followed by augmentation of the air-constituent of the atmosphere; and this result is peculiarly manifest at Newport in March. The temperature for October at Greenwich is comparatively very low; and we may suppose that the low temperature and abundant fall at Greenwich and in still higher latitudes bring about a greater accumulation of air there in November, December, and January than they do at Newport. Each of the three Tables shows an exceptional movement during the periods

of the year now referred to, that is to say, July and the three months last named; and these peculiarities, perhaps, are here in some measure accounted for.

Another discrepancy culminates on March 8; and this discrepancy has been anticipated, and some attempt has been made to account for it, in the work already named, more especially at pages 87, 88, 105, 106, 118, 119. A very high reading of the barometer is most likely proper to this season, over an extensive region; but the great excess that obtains at Newport, as compared with Greenwich, seems to depend upon a strong tendency in the atmosphere to flow in two opposite directions, viz. from the N.E. and from the S.W., and thus to occasion an inordinate accumulation. The Isle of Wight probably stands just in the course of these currents, and experiences the full influence of their joint action.

XIV. *On the Reduction of an Irregularly Progressing Series of the Regularly Succeeding Values of a specific term to Constant Average and Regularly Progressing Values.* By JOHN C. BLOXAM, Esq., M.R.C.S.

A GREAT impediment to the determination of meteorological laws arises out of the irregular progression of meteorological phenomena throughout the year. This irregularity is such that, if the daily values are averaged from 18 consecutive years, it is even then difficult to perceive whether the daily values rise or fall during a small portion of the year. If it should be found that regular curves are obtainable by averaging the daily values of 20 or 25 years, even this would not effect the object required, because so long a period as this might very possibly include a normal secular movement, which would necessarily be lost sight of by the expedient of averaging the whole together; the natural movement would be hidden instead of being detected. We want to elicit what may be called the centre of gravity on each day in the year of the continuous series—the centre of gravity as it actually exists in the series; and the shorter the period of years, the better, provided it be sufficient to give regularly increasing and decreasing values: 12 years is perhaps sufficient for this purpose, and certainly the term of years need not exceed 16. The process commonly used for the purpose is that by ordinates and abscissæ; but this method

does not appear to be satisfactory, and in my 'Meteorology of Newport' I have used and described another process which I think is clearly a better one. There is now an adequate means for determining the relative merits of the two methods. We have a Table of daily values, computed in the usual way, which may be relied upon for giving the best result that the method admits of. There can have been no lack of knowledge, skill, or accuracy in the computation of the Table; for it is Mr. Glaisher's work: if there be any defects here, they must be inherent to the method used.

In practising any meaning process of this kind, there is danger of obliterating normal curves in the line; and it is a condition of considerable weight that these curves should all be preserved, even though they be very small. Another condition to be respected is that the curves be evolved under the inherent action of the process used, and not be the result of discretion or opinion in the individual using it; so that uniformity may obtain in Tables constructed for different localities. The successive values ought to rise and fall in some regular rate of progression, and not by irregular jumps. It is quite necessary, in order that the method shall be satisfactory, that each of the values come out the same under everybody's hands: the value assigned to any day ought not to be dependent on the skill or the experience of the computor;—independently of blunders, there ought to be no room for diversity of results. It is indispensable that the 365 values, produced by the process, shall give the same sum-total as the original 365 values subjected to the process. There ought to be a ready means of testing the work as it progresses, so that blunders may be both detected and corrected with facility. The method proposed complies thoroughly with all these conditions. The method consists of a simple arithmetical calculation which must of necessity give a *true* result—provided only that no such error is committed as that of making two twos to be equal to five: the resulting values *must* be arithmetically correct, and I submit that they are so meteorologically.

The last Annual Report of the Society (1859–60) contains a Table (p. 29) numbered XIII., which gives the mean atmospheric pressure for every day in the year, as deduced from observations during 18 consecutive years; and in Table XIV. (p. 30, *op. cit.*) we have these daily means reduced to adopted average means by the usual process. I take it for granted that these adopted means are not merely what have been deemed to be the proper values for

each day in the year, but that they are supposed to give the values in Table XIII., distributed more equably and with statistical accuracy. I assume that the computation by ordinates and abscissæ is intended, like my own method of computation, not to take from or add to the *observed* heights, but to modify in some measure the daily incidence,—giving to one day what is taken from another. I have reduced the daily means of Table XIII. by the method I am recommending, and will now show the differences in the results of the two methods. In doing this there are two considerations specially to be kept in view, namely, truth and efficiency. Excellence in either one of these is quite compatible with total failure in the other. I submit that the arithmetical method does not and *cannot* fail in regard to truth; and it will be seen that it is quite satisfactory on the score of efficiency. The two methods will be compared with reference to the several conditions already laid down.

1. The method by ordinates and abscissæ produces 20 curves in Mr. Glaisher's Table XIV.; the arithmetical method gives 28: arithmetic *cannot* have made any of these 28 curves; it can only make manifest those curves that actually exist in Mr. Glaisher's Table XIII., though they are not readily seen there. There are 4 curves in Table XIV. which are not brought to light by the arithmetical method; and although this method is incapable of making curves, it is quite capable of obliterating them: but then its liability to obliterate a curve is precisely in proportion to the insignificance of the curve; and it has been shown that the arithmetical method preserves curves which are so small as to be lost by the other method. If any doubt remain as to which of the two methods the error here is attributable, this doubt will perhaps be dissipated when it has been shown that serious error does unquestionably result from one method, and not from the other. The arithmetical levelling process is progressive, and is limited in the range of its action—cutting down projections and filling up cavities that belong to a small portion of the line; and these daily irregularities are smoothed out before the range of action is large enough to obliterate the progressive curves that belong to several days in succession. The process is continued so far as to obliterate the daily irregularities,—stopping short of obliterating the progressive curves.

2. Uniformity is almost as important in these matters as correctness of result; and the most strict uniformity would be ensured if the arithmetical method were generally used.

3. That the regular progression of the values is obtained by the arithmetical method will be evident to any one who will take the trouble to inspect the Tables computed in this way in the 'Meteorology of Newport'*. These Tables, it may be observed, are deduced from 16 years of observation only, instead of 18. The accompanying diagrams† (Plates I. to IV.) exhibit the two lines as formed by the two methods respectively, in correlation; and it is easy to see which has the advantage as to the condition now under consideration. There is a great jump made on January 1 in Table XIV., which it may be well to give here in figures.

TABLE I. Regularity of Progression Contrasted.

	Table XIV.	Arithmetical.
December 30......	·001	·007
„ 31......	·002	·011
January 1	·071	·015
„ 2	·034	·017
„ 3	·020	·017
„ 4	·012	·017

4. Every calculator by the arithmetical process must obtain the same value for each day; but this can hardly be the case with the other process, if the values that have been produced be actually erroneous: we cannot expect identity in errors.

5. I now come to the condition referring to statistical accuracy; and if I can show any material error here, I think the method which is subject to the error must be held to be very unsatisfactory. The sum-total of the 365 values in Table XIII. exceeds the corresponding sum in Table XIV. by 0·939‡ in.—this making a difference of ·0026 in the annual means. The sum-total of the values produced by the arithmetical method is identical with that of the values in Table XIII. from which they have been educed.

6. The correctness of the calculations by the arithmetical method may be tested with the utmost facility as the work progresses; but whether the same can be said of the other method, I have no means of determining.

* A copy of this is in the Society's library.

† The letter A indicates the arithmetical line, and the letter O the other.

‡ I have assumed that a typographical error exists in Table XIV.,—·774 being apparently printed instead of ·784, for June 16. I have ventured to correct this; and if I am wrong in doing so, the difference will be ·949 instead of ·939.

I will now point out some other discrepancies in the results of the two methods of computation. The following Table gives the monthly means belonging to Table XIII., the monthly means belonging to Table XIV., and the monthly means belonging to the arithmetical mode of reduction; also the differences between the first and second columns and those between the first and third columns.

TABLE II. Monthly Means contrasted.

	Table XIII.	Table XIV.	Arithm.	Difference, Table XIV.	Difference, Arithmetical.
January	29·745	29·748	29·760	+ 3	+15
February ...	29·786	29·793	29·776	+ 7	−10
March	29·812	29·842	29·803	+30	− 9
April	29·716	29·752	29·742	+36	+26
May	29·763	29·753	29·763	−10	0
June	29·804	29·799	29·805	− 5	+ 1
July	29·793	29·795	29·790	+ 2	− 3
August	29·797	29·792	29·801	− 5	+ 4
September ...	29·844	29·838	29·839	− 6	− 5
October	29·689	29·705	29·694	+16	+ 5
November ...	29·743	29·745	29·746	+ 2	+ 3
December ...	29·833	29·818	29·818	−15	−15

The mean amount for the first column of differences is 11, whilst that for the second is 8. Now it is evident that, other things being the same, that method of reduction is best which deranges the original values the least; and here the method which deranges in the smallest degree has the additional advantage of giving the most regular curves. That method of reduction cannot be satisfactory—cannot be correct, I might say—which raises the values of four months in succession; and here we have the four first months raised, on the average, as much as ·014 in.

The next Table gives the maximum and minimum for each month, together with the dates of their occurrence, as these particulars appear in Table XIV.; also the same particulars as they are determined by the arithmetical computation.

The dates generally correspond pretty closely, but there are some marked discrepancies. It seems quite clear, and quite certain, that the arithmetical method cannot be in fault here; and, indeed, if the reducing process is carried to excess, so as to obliterate normal curves, the *dates* of the remaining curves are not materially altered. The maxima of Table XIV. are on the average ·007 in. lower than the arithmetical maxima, whilst the minima are ·015 in. higher. The *tendency* of the arithmetical process is to lower the upper curves and to raise the lower curves; but it

cannot operate in the opposite directions. There is, consequently, very decisive evidence that the range for the year is unduly contracted by the reducing process used for Table XIV.

TABLE III. Monthly Maxima and Minima contrasted.

	Table XIV.				Arithmetical.			
	Dates.	Maxima.	Dates.	Minima.	Dates.	Maxima.	Dates.	Minima.
January ...	1	29·826	12	29·722	1	29·839	10	29·730
February	18	29·815	6	29·765	28	29·826	1	29·749
March......	8	29·938	31	29·752	8	29·899	31	29·715
April	28	29·773	8	29·737	20	29·787	8	29·686
May	31	29·795	17	29·735	31	29·831	19	29·743
June	28	29·819	16	29·784	2	29·835	13	29·779
July	11	29·820	31	29·753	11	29·806	31	29·765
August ...	31	29·879	5	29·748	31	29·917	6	29·750
September	6	29·910	30	29·708	2	29·924	30	29·663
October ...	31	29·746	6	29·687	31	29·750	5	29·630
November	8	29·801	23	29·684	8	29·815	23	29·668
December	29	29·900	1	29·731	28	29·874	1	29·745

If we proceed upon the assumption that the arithmetical method is statistically correct, it then turns out that in January one of the values in Table XIV. is wrong to the amount ·033; in February, to the amount ·019; in March, ·065; in April, ·051; in May, ·037; in June, ·035; in July, ·017; in August, ·038; in September, ·045; in October, ·057; in November, ·016; in December, ·043. The arithmetical method shows the maximum for the year to occur on September 3, whilst the other method makes it fall on March 8; the arithmetical method shows the minimum to occur on October 5, whilst the other makes it fall on November 23.

I have shown that the two systems give very different results, and that one must consequently be much superior to the other. I have shown, beyond all doubt, that the system commonly used leads to serious error; and I think I may now venture to say that the method proposed has the advantage of the usual method in regard to efficiency, as well as in regard to accuracy. There is one other point remaining for consideration, namely, the time and trouble the proposed method may entail. I do not know how much time is required for the usual method; but I kept account of the time I spent in the arithmetical calculations, and the time occupied by the primary calculations and their subsequent verification amounted to five hours.

I need not enter here very fully into the nature of the method I advocate, because I have already done this in my published

work; but I may describe it shortly. The method is founded on the fact that, in meteorology, the mean value of 10 or 11 consecutive days gives more correctly the normal constant value for the middle day of the series, than the middle day itself does; and then the value for every day in the year having been calculated upon this principle, this whole series of amended values can in turn be subjected to the same process; and the process may be reiterated until the daily values are brought to sufficiently regular ascending and descending lines. In the present case the process was twice carried through; and this seems to be all-sufficient for the purpose in view. The special characteristic of the method, perhaps, consists in its combining great *meaning efficiency* with a small range of *meaning action*.

XV. *The Gales of November* 1861.

By W. Moffatt, Esq., M.D., F.R.A.S.

The following remarks on the gales of November 1861 are from observations taken at 14 stations in England and the Channel Islands. The observations are for each degree of latitude between 49° and 55°, and of longitude between 1° E. and 5° W.

The gales to which the remarks refer are those of the 1st and 2nd, the 4th and 5th, the 10th, the 13th and 14th of November. The first was confined chiefly to the North Sea and the coast of Yorkshire and Northumberland. That of the 4th and 5th was felt chiefly on the south coast, and was accompanied by a very high tide. That of the 10th was felt on the west coast, and did much damage in London and on the east coast. That of the 13th passed over Guernsey; and on the evening of that day, and on the 14th, a hurricane prevailed on the east coast. These gales were accompanied by thunder and lightning, much rain, hail, and snow-showers, sudden changes in the direction and force of the wind, great ranges in the readings of the barometer and thermometer, and frequent variations in the tension and kind of electricity and in the quantity of ozone. The gale of the 10th was at its height at this place (Hawarden, near Chester) from 2 to 5 o'clock A.M. It was accompanied by thunder and lightning, 0·450 of rain fell, and the barometer readings decreased upwards of ½ an inch (0·608). At this time the direction of the wind was

easterly. From 8 A.M. till noon, the air was so calm that the direction of the wind could just be perceived by an inclination of the smoke of chimneys from N.E. At 3 P.M. the readings of the barometer began to increase; there were occasional gusts of wind from S.W. A gale at length set in from that point, and continued through the night and following day. The eastern portion of this gale was not perceived at Liverpool (20 miles N.E. from this place), the force of wind there averaging only 8 lbs. to the square foot; but the western part was felt on the morning of the 11th, and gave an average pressure of from 17 to 22 lbs. to the square foot. The gale that passed over Guernsey on the 13th blew hard from N.E., with heavy rain, from 9 A.M. to 1 P.M. From this time the wind veered to S.E., then to S.W. A short lull took place, with mist, and the temperature rose 10° (from 48·5 to 58·5) (Dr. Hoskins). A gale commenced on the east coast on the night of the 13th, and continued a hurricane during the 14th at Yarmouth and Shields.

Viewing these gales in their dynamical effects, we see the results of contending or opposing forces; and, in a meteorological sense, we perceive currents of air differing widely in their meteorological elements. As that of the 1st and 2nd November was the most important in its results, and invites discussion by the distinctness of its phases, it may be described as a type of the others.

The commencement of the series of meteorological processes which led to these gales dates from the 26th of October. For a few days previous to that date, there was a gradual increase in the readings of the barometer. On that day they reached their maximum. There was a slight decrease on the evening of the 26th and during the 27th, which was followed by a corresponding increase on the morning of the 28th; but from this date the decrease became general all over England, the Channel Islands, and North of Europe; and it continued until the 2nd of November. Decrease of temperature observed the same rule. The general direction of the wind over England, from 26th of October to the 30th, was easterly (or north-easterly) (polar); while N. of 55° it was westerly (or south-westerly) (equatorial). On the 31st, westerly winds prevailed at all the stations S. of 55°. On the 1st of November, the direction of the wind N. of 55° was north-easterly and northerly, while S. of that it was westerly. On the 2nd of November, N. of 55° the current was still polar, while S. of that degree it was chiefly equatorial; but on the east coast of Yorkshire and Northum-

berland it was a combination of the two. On the 1st, the lowest temperature and atmospheric pressure were N. of 54°; but on the 2nd these conditions were S. of 55°: the lowest temperature on the former date was with a N.E. wind, while on the latter it was with a S.W. wind. On the 2nd, the barometer readings also increased N. of 55°, but S. of it they still decreased. The mean decrease in the readings of the barometer at the 14 stations, from the 26th of October to the 2nd of November, was 0·857 in.; the greatest at one place being 1·260 in., and it occurred in lat. 54°. The mean decrease of temperature at all the stations was 8·5; the greatest range taking place in lat. 52°, differing only about 0·5° on the east and west coasts. While easterly winds prevailed from the 26th to 30th of October, ozone was at its minimum. From the 28th of October to the 1st of November, the mean daily quantity of ozone was 2·9. On the 2nd of November it was 5·9. It increased in quantity on the 31st, while the general direction of the wind was westerly; but on the 2nd of November, the maximum was with N. and N.E. winds, and the minimum with N.W. and W. From the 26th of October to the 3rd of November, in 26 observations of the electrometer, the signs were 11, or 42·3 per cent., positive, and 15, or 57·7 per cent., negative.

As the south or negative current of the air is much more frequent at this place than the north or positive, the electric signs are much more frequently negative than positive. For instance, for the three months previous to the 26th of October, in 129 observations of the electrometer the signs were twelve times, or 9·3 per cent. only, positive, and 90·6 per cent. negative.

On the 1st and 2nd of November, hail and snow fell at thirteen stations; thunder and lightning or thunder-storms occurred at eight; and the aurora was observed at two.

Taking a general view of these observations, we perceive that the general direction of the wind over England and the Channel Islands, from the 26th to the 30th of October, was north-easterly or polar, and that N. of 55° it was south-westerly or equatorial; and that on the 31st, the equatorial had the ascendency both N. and S. of that degree of latitude. These two currents differ widely in their meteorological conditions. The N. or polar is dry, positively electric, causes maximum of barometer reading and minimum of temperature, and contains the minimum of ozone; and snow falls more frequently on the polar side of the compass than on the equatorial. The S. or equatorial current is moist, negatively electric, causes decrease in the readings of the barometer

and increase of temperature, and contains the maximum of ozone; and hail falls more frequently in equatorial than polar points of the compass. Between these two currents there is a constant struggle; and the conditions of the one or the other are perceived at a locality, just as the one or the other prevails. The result of this struggle is not unfrequently an eddy—a revolving storm or cyclone.

From 26th to 31st of October, and on the 1st of November, we observe that first one of these currents, and then the other, prevailed. We see the frequent changes in the kinds of electricity, corresponding changes in temperature, in atmospheric pressure, and in the quantity of ozone—all indications of a coming struggle; in the latitudes where the changes from one current to the other took place, viz. between 54° and 55°, we perceive, on the 2nd of November, all the elements of a revolving storm or cyclone. In these revolving storms there is a central calm which corresponds with the greatest barometrical depression, and round which the wind circulates and increases in force as the centre is approached from the circumference. As the greatest barometrical depression, then, was observed on 2nd of November in lat. 54° N. and long. 0° 25′ W. (Scarborough), and as the wind was then at its greatest force, we may reasonably conclude that the central calm was off the coast of Scarborough, in the German Ocean. At Scarborough, the decrease of the barometer was 1·250; N., S., and W. of this place (I have no observations E. of it), the amount of decrease gradually diminishes; and in lat. 49° it is 0·525 in., or only one-half. We see in the direction of the wind the circular movement. At Scarborough and N. of it the wind was N. and N.E.; W. of it, it was N.W.; and S. it was W.; and in the German Ocean, ships returning from the Baltic encountered a hurricane from the S.W. According to the rule also, in northern latitudes, that when we face the wind the calm is to the right hand, the central vortex must have been in the German Ocean; and, in proof of this, it may be stated that ships returning from the Baltic were becalmed 60 miles off the east coast, while the sea was much agitated. As the gyration of these storms in N. latitudes is from right to left, or contrary to the hands of a watch, and as they consist of both currents and possess their meteorological elements, the eastern portion of the circulating mass must consist chiefly of the equatorial, and the western of the polar current,—distinctions, however, which must be gradually lost by intermixture. It is owing to this that we at times perceive an easterly wind possess

the elements of a westerly, and *vice versâ*. By the foregoing observations we have seen that the *maximum* temperature and the greatest quantity of ozone on the 1st and 2nd of November were with the northerly current, and that hail fell most frequently with the same current with a mean temperature of 44°·0, while the *minimum* of temperature and the minimum of ozone were with a westerly current, and that snow fell most frequently with the same current at a mean temperature of 36°·0;—in fact, the equatorial became a polar, and the polar an equatorial, in direction. Although the cyclone was confined to the east coast and the German Ocean, as before stated, and the force of the wind over England was not more than an average of 4°, still there was an increase of force for the day at all stations, and the general direction indicated a *draft* to a common centre.

These storms, like all of their class, were accompanied by diseases of the nervous and muscular systems. During their prevalence two cases of paralysis, one of vertigo, and one of apoplexy came under my notice. Similar cases occurred during the succession of gales from the 21st to the 30th of October, 1859 (the 'Royal Charter' was wrecked on the 26th). Between the above dates, five cases of apoplexy, epilepsy, and paralysis came under my notice. There were hail and snow showers—variations in kind and tension of atmospheric electricity; thunder-storms occurred, and the aurora was observed. On the 25th of January, 1860, there was one case of paralysis, one sudden death, and one case of convulsions. All were in a line with each other, and in two miles' distance; and they took place in nine hours. On the 26th, a gale passed over this place, with hail-showers. Frequent changes in the tension and kind of electricity take place with, or accompany, hail and snow showers; and there appears to be an intimate connexion between them and the above class of diseases. Of 236 cases of apoplexy, epilepsy, paralysis, vertigo, and sudden deaths, which have come under my notice in ten years, 63·5 per cent. were intimately connected with falls of hail and snow, and 16·4 per cent. took place on days of rain-showers, which were in all probability melted hail or snow. I have often seen the electrometer give a negative sign with a shower of rain, while hail was falling at one or two miles' distance. These diseases are most frequent at the commencement of ozone periods,—in short, at the time of transition from the polar and positively electric to the equatorial and negatively electric current of the air. We can easily believe it possible that an electric cloud or stratum of air might, by the pro-

cess of induction, produce changes in the distribution of electricity in the animal economy, and produce thereby such diseases; still experiments have not hitherto given results favourable to this opinion. I am more inclined to believe that, by the action of the two electricities, a force is produced in the atmosphere, hitherto undiscovered, analogous to the nervous and muscular forces. If such a force does not exist, the conclusion that the animal economy is more susceptible of changes, in the electric condition of the atmosphere, than the most sensitive electrometer, cannot be avoided. I have often been warned of the approach of a storm, or even a change in the direction of the wind,—while the storm yet raged under the horizon, and the approach of the equatorial current could be foretold only by the appearance of cirri on the south-western horizon,—by the occurrence of one or more of the above diseases, the electrometer and barometer not having shown the slightest indication of change. It must be observed, however, that the change from a positive to a negative condition of the atmosphere, or even an increase in the negative tension, often indicates the approach of a storm, or change in the direction of the wind, long before there is any depression in the mercurial column.

XVI. *The 'Royal Charter' Storm.*
By H. S. Eaton, Esq., M.A., Librarian.

(Note.)

Mr. Eaton had commenced discussing certain features of this celebrated storm, which occurred in 1859, October 25 and 26. In anticipation of the communication which he hoped to submit at a future meeting of the Society, he made a few verbal remarks, and referred to Tables which were in progress, and of which some portions were before him, and which had reference to the pressure of the atmosphere at different points of the circle which included the storm. The nature of his argument will be gathered from the following Table.

Assuming the point of minimum pressure as the centre of the storm, the following Table gives the position of the centre, its rate of progress, the increase of pressure in each 100 miles from its centre, and the absolute minimum pressure at the sea-level.

1859, October.	N. latitude.	W. longitude.	Rate of progress, in miles per hour, since last observation.	Increase of pressure for each 100 miles from the centre towards the circumference.				Absolute minimum pressure.
				0–100.	100–200.	200–300.	300–400.	
d. h.	° ′	° ′		inch.	inch.	inch.	inch.	inches.
25 9 A.M.	49 0	6 10	...	...	...	...	...	...
25 3 P.M.	49 50	4 0	19	0·50	0·25	0·10	...	28·60
25 9 P.M.	51 15	3 30	17	0·28	0·35	0·15	...	28·75
26 3 A.M.	52 20	2 30	16	...	...	...	...	...
26 9 A.M.	53 0	0 0	18	0·17	0·28	0·20	0·15	28·85

XVII. *Watch-case Aneroid.* By Messrs. Negretti and Zambra. (Memorandum.)

In No. 1 of the 'Proceedings,' p. 84, is a description, with an engraving, of a very small aneroid barometer, peculiarly portable.

Mr. Zambra, this evening, submitted to the Members a still smaller form of aneroid, one which can literally be called a pocket-instrument. It is contained within a watch-case, the case being somewhat larger than that of the watches carried by railway guards.

No particulars were given of the performance of the instrument; it was in fact only recently completed, and was the first of the kind constructed.

BOOKS AND NOTICES.

VII. *Magnetic Storms and Earth-Currents.*

Dr. Lloyd—'Transactions of the Royal Irish Academy,' vol. xxiv. pp. 115–141, two plates. 1861, November 11 and 30.
C. V. Walker—'Proceedings of the Royal Society,' vol. xi. no. 48. pp. 578–582. 1862, February 13.

Dr. Lloyd proposes "to show that the diurnal variation of the horizontal magnetic needle is due to electric currents traversing the earth's crust," and to "proceed to examine some of the laws

of these currents." He refers to the papers communicated to the Royal Society by Mr. Barlow, and read May 25, 1848, who established "that a wire, whose extremities are connected with the earth at two distant points, is unceasingly traversed by electric currents, the intensity of which varies with the azimuth of the line joining the points of contact with the ground......, and wholly independent of the course followed by the wire." Observations led him "to the conclusion that, although generally the currents flow *southwards* during that part of the day in which the variation of the horizontal needle is *westerly*, and *northwards* when the variation is *easterly*, yet simultaneus observations showed no similarity in the paths described by the magnetic needle and the galvanometer."

On examining the observations referred to, Dr. Lloyd arrived at an opposite conclusion; and he stated to the British Association, at their last Meeting, his conviction that these earth-currents "would eventually explain all the changes of terrestrial magnetism, both periodic and irregular."

He adverts "to a difference between the things compared." Mr. Barlow's curves show that the galvanometer-"needle oscillates from one side to the other of the zero alternately...... These movements are similar to those of the magnetometers, with which we are familiar; but they are much more *rapid*, and bear a *larger* proportion to the *regular* changes." On one day, which happened to be a term-day of the magnetic system, there were "on the average 5·1 alternations of the galvanometer-needles in the hour, the corresponding number of alternations of the magnetometer being only 3·1....... And the disproportion in the magnitude of the deflexions ......appears to be even more considerable." From certain comparisons made by Dr. Lloyd, it came out "that the rapid changes of the earth-currents are much greater, in proportion to the regular daily changes, than the corresponding movement of the magnetometers;" and he concludes "that little or no accordance is to be expected in comparing the *individual results* of the two classes of measures." He therefore compared the magnetometric observations with the *means* of several galvanometric observations: he took the mean of each pair of succeeding hourly means. "On examining them, it will be seen that the law of the diurnal changes in the force and direction of the currents is very systematic."

He then compares "these results with those deducible from the diurnal changes of the magnetic declination and horizontal force, on the assumption that the forces which produce the latter are due to electric currents traversing the upper strata of the earth;" and he gives curves of the intensity of the earth-currents, as observed by Mr. Barlow and as calculated by himself. "The agreement of the calculated with the observed curves is probably as close as could be expected in the results of so short a series;" and "the curves of both lines exhibit a general resemblance to the course of the diurnal variation of the declination." "The *turning-points* of the *calculated* curves are generally *later* than those of the *observed* by about one hour." But he has "grounds for believing

that *time* may possibly be required, in order that the current may produce its full magnetic effect." "The comparative quiescence of the magnets during the early hours of the morning seems to indicate that they are *then* near their true positions of equilibrium." There is no means of determining this absolutely; but the character of the galvanometric curves at this period of the day seems to confirm this indication, and to lead to the inference that the true zero is between the mean of the day and the mean of the hours of repose. But a fortnight's observations are not enough to justify a change "in the origin usually employed." Yet "if the galvanometric and the magnetometric results were completely identified, the zero of the latter could readily be obtained by their comparison."

The author then proceeds to give "the manner in which the electric currents may be supposed to operate in producing the magnetic effects." Traversing the earth in a horizontal direction, they "may affect a horizontal magnetic needle above its surface in two different ways"—acting either "*directly* upon the *needle* according to the known laws," or inducing "*temporary magnetism* in the earth itself, which will thus affect the needle differently from before;" and he thinks "that the former hypothesis is inadmissible, at least as regards the principal part of the observed effect," on account of "the known similarity in the course of the magnetic changes over considerable portions of the earth's surface—a similarity incompatible with the supposition that the magnet is directly acted on, to any great extent, by the subjacent current." He assumes that a wave of currents, sweeping over the earth's surface, acts to a considerable depth, and alters the magnetism of the subjacent mass by induction, "and that the effect produced upon the freely suspended magnet at its surface is the result of this induced change;" so that the magnetic phenomena "are the *indirect* effects (not of the subjacent current merely, but) of the entire wave traversing an extended portion of the earth's surface."

On this hypothesis differences might be expected, as is found to be the case, between the observed and computed values of the currents. "For the galvanometric measures belong only to currents at the place of observation; while the magnetic changes are, by hypothesis, the mean results of currents occupying a considerable portion of the earth's surface." So that a complete identification can only be looked for from "simultaneous observations of earth-currents at numerous points in an extended district."

Dr. Lloyd concludes that the correspondence between the waves of earth-currents and the variation of terrestrial magnetism, noticed by Dr. Lamont, relates "to the *epochs* of the two classes of changes, and not to their *amount*;" the more so as that philosopher considers (*vide* 'Proceedings of the British Meteorological Society,' No. 2. p. 132) that his "galvanometer indicates not the earth-current itself, but its *momentary changes*;" and, if such were the case, "there could be no correspondence......between the magnitude of the magnetic changes and the deflexions of the galvanometer." Referring to the anomalous results given by Dr. Lamont (*vide*

ibid.), the author "suggests that it may be due to some disturbing cause;" and quotes "a fact well known to telegraphists, that the current produced by chemical action upon the terminal plates interferes with the primary current much more in *short* than in long wires,"—Dr. Lamont's wires being comparatively short.

Having shown "the dependence of the diurnal changes of the horizontal needle upon earth-currents," he reasons from the former to deduce the laws which govern the latter. From formulæ he gives, and from magnetic values obtained at Dublin, he has prepared a Table of the Intensity and Azimuth of Earth-currents for Dublin for every hour of the day, in summer, in winter, and the mean for the year. He has also given a diagram conveying a graphic representation of yearly value given in the Table, "the radius-vector of the curve measuring the intensity of the current, and the angle which it makes with the meridian its azimuth." From 1 to 6 A.M., the mean azimuth of the earth-currents is calculated to be N. 21° W.; at about 7.15, due N.; at 10.25 it is E.; at 3.15 P.M. it is S.; and at 7.35 P.M. it is W. "Finally, after midnight it reaches its stationary position to the W. of N." The principal differences between summer and winter are the times of reaching certain azimuths; and "the *maximum intensity* occurs at 1 P.M., the azimuth of the current being then S. 35° E. There is a *secondary maximum* about 7 P.M."

"In the foregoing deductions ......, the current referred to is not that actually subjacent to the place of observation, but the resultant for that place of all the currents occupying a considerable portion of the earth's surface. The reasoning, in fact, relates to the magnetic effects of the currents, rather than to the currents themselves,"—the conclusions being affected by the uncertainty "respecting the zero or origin from which the magnetic deflections are to be measured," which uncertainty only affects the results when the magnetic variations are small.

As there are marked differences in "the diurnal changes of the magnetic elements at different points of the globe ......, corresponding differences must therefore be expected in the diurnal changes of the earth-currents at different places;" so that Dr. Lloyd thought it would reward the labour to make calculations similar to the above for all places at which hourly or bi-hourly magnetometric observations had been made for a lengthened period. He has done this for thirteen places at which there are magnetic observatories,—Greenwich of course being one, and which "is very similar to that of Dublin." He gives graphic delineations, eight in number, of results, and descriptive remarks, from which he is enabled to infer the extent to which the laws common to earth-currents are departed from in particular instances. "And from a consideration of the physical circumstances of the localities in which these deviations occur, we may, in some cases at least, be enabled to trace them to their probable origin."

He gives a Table showing that the direction of the earth-current in the northern hemisphere changes according to the same general

law,—the mean time of the E. current being 10.36 A.M.; of the S. current, 2.30 P.M.; of the W. current, 7.10 P.M. As far as can be gathered from the Hobarton phenomena in the southern hemisphere, "the rotation of the currents is in the *opposite direction* to that in the northern;" from which it seems "that the point to which the earth-current is directed in all cases *follows the sun*."

"The force of the current is *greatest* in the northern hemisphere ...... between noon and 2 P.M., being earliest in the British Islands, and latest in Western Siberia" ...... "The mean time of the maximum is 1.25 P.M."

"The *direction* of the current of *greatest intensity* seems to be connected with the *magnetic meridian* of the place of observation." ...... "The mean direction of the current of greatest intensity, referred to the magnetic meridian, is S. 8° E." ...... "And the directions of the *greatest* and *least* currents are, in nearly all cases, exactly opposite."

Although the phenomena of the diurnal variation of earth-currents "have much in common, there is at the same time great diversity in the details," the peculiarities at some places being remarkable; and on these the author makes a few remarks. He refers to two periods in the day, when the direction of the current is constant for four hours and eight hours respectively, at Munich and at Prague, being S. 30° E. and N. 50° W.; and is "led to conclude, therefore, that there is something in the structure of this part of the earth's surface which allows an easier passage to the electric current in these definite directions than in others, and which thus *fixes* the direction of the current when, by the operation of general causes, it is made to approach either of these lines. It is highly probable that this property belongs to mountain-chains, which, by their homogeneity, as well as by the higher conductibility of the rocks of which they are composed, may be supposed to give a freer passage to the current than other parts of the earth's crust;" and he refers to certain mountain-chains here present. At Philadelphia there are two constant periods, of four hours each,—the fixed directions, however, being S. 25° W. and N. 6° E.,—which he suggests may be due to the influence of the line of coast or of the chain of the Alleghanies; and other analogous specialities are referred to.

In conclusion, Dr. Lloyd remarks that this "great diversity in the midst of order ...... in the diurnal changes of the earth-currents cannot be wondered at, when we consider the endless variety which exists in the distribution of land and water on the earth's surface, as well as in the configuration of the land itself, and in the materials of which it is composed." And, from the probable connexion herein traced between the phenomena and these physical circumstances, "we are encouraged to hope that the complex phenomena of the diurnal change may at some future time be completely unravelled, and the peculiar features which it presents at each place traced to their cause." To which end, it is desirable to determine the influence of lines of coast, mountain-chains, and other physical conditions, over the two magnetic

elements, which "would add little to the labour or expense of our numerous exploring expeditions."

Mr. Walker has made observations upon the currents pervading the earth during "calm" seasons, which have prevailed, almost without exception, since January 1861. Wires peculiarly adapted to this investigation happen to enter his own office at Tunbridge. He says, "The telegraph needles have been rarely affected of late, the earth-currents, which form the subject of the present communication, being feeble. In order to their examination it was therefore necessary to prepare a delicate galvanometer, which is properly connected with the telegraph-wire, and furnished with the simplest possible apparatus for bringing it into action whenever occasion serves. It is within arm's length of the author when in his office. The pressing-down of a spring allows any earth-current that may be present to enter the galvanometer."

A Table is given of earth-currents collected in October 1861, followed by an analysis which includes a like series collected in the following month. The day, the hour, and the direction of the currents are given; and the observations were made on lines in two favourable azimuths, making an angle of 149° with each other, confirmed by a third intermediate line.

"The contents of the Table are divided into *Normal*, *Abnormal*, and *Exceptional*. Out of a total of 276 observations, 230 gave *normal* results, confirming the conclusion already arrived at, that the prevailing direction of earth-currents was approximately N.E. or S.W." "The author has reason to conceive that sunshine or cloud, heat or cold, influence the relative values of the current collected from different parts of the same district; in connexion with which he refers to a group of night observations, which form part of the series made in October, and also to the want of consistency in the relation between two derived currents collected at the same time from different parts of the same plane."

Of *abnormal* currents 42 cases occurred, which, on being discussed, indicated that the direction of the earth-currents to which they were due was to be found in the S.E. and N.W. quadrants.

A survey was made "of the N. and S. boundaries of a plane, the mean dimensions of which are 56 miles × 20 miles, bounded on the N. by the Thames, and on the S. by the Dover-Tonbridge line of railway." "A Table is given of observations made during November and December, which show that the plane of the current is at least 20 miles wide, and the direction is consistent at either limit of the plane."

"Tonbridge, being very nearly midway on a line joining London and Hastings, gave the opportunity of making observations on the whole or on either half of a same line of country. The results collected in November and December are given in a Table, and show a conformity in direction in the whole and in both halves, but a marked excess in value in the London-Tonbridge as compared with the Hastings-Tonbridge section. These differences

are considered by the author as probably due to the different geological conditions of the country on either side of Tonbridge."

"In order to satisfy himself that he was dealing with currents collected *boná fide* from the earth, ... observations were made ...... showing that no portion of the result was derived from any other source than the earth."

The absence of polarization, or of the special electro-motive force of the earth-plates themselves, as causes of the currents here collected, was tested experimentally. The purposes for which telegraph-wires are erected define the limits within which the author's observations can alone be made; but he looks forward to the results that will be derived from the continuous observations that will very shortly be commenced in the Royal Observatory. The conclusions to which he arrives are:—

"1st. That currents of electricity are at all times moving in definite directions in the earth.

"2nd. That their direction is not determined by local causes.

"3rd. That there is no apparent difference, except in degree, between the currents collected in times of great magnetic disturbance and those collected during the ordinary calm periods.

"4th. That the prevailing directions of earth-currents, or the currents of most frequent occurrence, are approximately N.E. and S.W. respectively.

"5th. That there is no marked difference in frequency, duration, or value between the N.E. and the S.W. currents.

"6th. That (at least during calm periods) there are definite currents of less frequency from some place in the S.E. and N.W. quadrants respectively.

"7th. That the direction of a current in one part of a plane on the earth's surface (at least as far as the S.E. district of England is concerned) coincides with the direction in another part of the plane; and if the direction changes in one part, it changes in all parts of the plane.

"8th. That the relation in value between currents in a given part of the plane and currents in another given part is not constant, but is influenced by local meteorological conditions, and varies from time to time.

"9th. That the value of the current of a given length, moving in a given line of direction, is not necessarily the same as of a current of the same length on the same line of direction produced, and that their relative value depends on the physical character of the earth interposed between the respective points of observation, and is tolerably constant.

"10th. That the currents which have formed the basis of these investigations are derived currents from true and proper earth-currents, and neither in whole nor in any appreciable part have been collected from the atmosphere, nor are due either in whole or in any appreciable part to polarization imparted to earth-plates by the previous passage of earth-currents or of powerful telegraphic currents; nor are they due to any electro-motive force in the earth-plates themselves.

"11th. That the earth-currents in question (at least the powerful currents present at all times of great magnetic disturbance) exercise a *direct* action upon magnetometers, just as artificial currents confined to a wire exercise a direct action upon a magnet."

[A copy of this Abstract is in the Library.]

VIII. *British Rain-fall.—On the Distribution of Rain over the British Isles during the years* 1860 *and* 1861, *as observed at about* 500 *stations in Great Britain and Ireland.* Compiled by G. J. SYMONS. Pp. 18. 8vo. 1862, February 15.

THE author has proposed to collect and arrange "the observations of rain-fall in the British Isles,"—a work that will occupy much time. Meanwhile he printed for private circulation the rain-fall of 1860, which he now reprints and publishes with that for 1861, and proposes to publish a summary annually. He says, "the Tables have been compiled with such care that it is hoped they are almost, if not quite, accurate."

In classification, he has grouped the counties, on the plan adopted by the Registrar-General, giving the stations in order of latitude from S. to N.

On account of the "extraordinary differences of opinion that exist as to what constitutes a rainy day," the writer has refrained from complying with a request often made to him "to give the number of rainy days."

Independently of this publication, he writes, "the collection of old observations being still in progress, any information respecting rain-registers, past or present, will be esteemed a favour."

"The mean of the ten years 1850 to 1859 has been adopted as a standard of reference," the fall "being within about 5 per cent. of the average during the last half-century."

The rain-fall of 1860 was more than 40 per cent. in excess on the east coast of England, scarcely 3 per cent. in the north and north-west of Scotland, and about 25 per cent. at the majority of stations.

In 1861, the fall in England was below, that in Scotland above the average. "The maximum deficiency (34 per cent.) was at Empingham" in Rutland, where the fall in 1860 had been 23·52 in., and in 1861 was 15·42 in. "Along the west coast, the year was wetter even than 1860, being in places more than 40 per cent. above the mean." At Leathwaite, Borrowdale, Cumberland, "the fall in 1861 was 182·58 in." The fall in the previous years had been 142·2 in. The average fall is 126·98. "The enormous quantity of 35·41 in. was measured in November, this being, like the annual total, hitherto unequalled."

The two years taken together, the excess in Scotland was 13 per cent.; in England, 17; in the kingdom generally, 15.

The classification is as follows:—

Divisions.	*England and Wales.*	Stations.
I.	Middlesex	13
II.	South-eastern Counties	90
III.	South-Midland Counties	25
IV.	Eastern Counties	20
V.	South-western Counties	62
VI.	West-Midland Counties	25
VII.	North-Midland Counties	37
VIII.	North-western Counties	42
IX.	Yorkshire	39
X.	Northern Counties	32
XI.	Monmouthshire, Wales, and the Isles	11
	Scotland.	
XII.	Southern Counties	6
XIII.	South-eastern Counties	16
XIV.	South-western Counties	19
XV.	West-Midland Counties	14
XVI.	East-Midland Counties	37
XVII.	North-eastern Counties	9
XVIII.	North-western Counties	7
XIX.	Northern Counties	6
	Ireland.	
XX.	Ireland	21
	Total	531

[A copy of this Pamphlet is in the Library.]

IX. *On the Meteorology of Newport, in the Isle of Wight, as deduced from Observations carried on during the Sixteen Years* 1841–1856. By JOHN CHARLTON BLOXAM, M.B.M.S. 4to. Pp. 149, 24 Tables, 67 plates. Second edition. 1860.

THIS Essay takes a wide range; it gives an analysis, as well as a summary, of the particulars recorded,—the facts being discussed both in detail and in combination, with the view of indicating their import, their causes, and their interdependence. The particulars characterizing the site of observation and its neighbourhood are stated, and a full description is given of the apparatus used, the way in which the observations were conducted, and the methods resorted to for averaging and tabulating the various details of the original record. The subjects to which observation was directed, and of which a systematic history is given, are the following, viz., temperature, dew-point, atmospheric pressure, dry-air pressure,

vapour-pressure, humidity, fall of rain, days of rain, amount of cloud, daily change of atmospheric pressure, direction of wind, force of wind. The meteorological history of the year is given by detailing and discussing the facts connected with the first ten of these subjects for each of twelve divisions of the year consecutively. This duodecimal division of the year does not coincide with that adopted for almanacs, but is based upon the progress of temperature,—the coldest thirty days in the year being taken to constitute the coldest month—the hottest thirty days the hottest month; and the seasons are also determined in the same manner,—the coldest ninety-one days being taken to constitute the winter, and the hottest ninety-one days the summer.

The history of each of the twelve divisions having been given, *seriatim*,—the progression of the several particulars having been specified, the characteristics of each division indicated, and the laws of meteorological action discussed,—the movements of the atmospheric constituents are then made a distinct subject of investigation. One period of the year is shown to be characterized by the presence of a great amount of dry air, another by active evaporation, a third by the presence of a great amount of vapour, and the fourth by active deposition: the essential statistics for each of these periods are given, and some other particulars also. The reciprocal action of air, vapour and temperature on one another is then dealt with,—the facts being detailed and analysed, and the laws they indicate discussed.

The direction of the wind is next taken into consideration, and discussed in its connexions; first, more particularly with atmospheric pressure, and subsequently in connexion with temperature and hygrometry. The actual combinations of the first particular with the others are given statistically, and inferences are drawn from the facts. The laws of action in regard to the direction of wind are then elucidated, by connecting the *exact* direction with divers other meteorological phenomena—phenomena which give a marked character to nine special periods of the year. The direction of the wind is thus put in correlation with periodical phenomena which are essentially characteristic of the respective periods. The *point* of the compass is here referred to as the exact direction, the direction having been originally recorded under the thirty-two heads or points. A marked feature in this part of the investigation consists in the values being given for each of the thirty-two points; and the lower values are referred to, as being as suggestive as the higher ones.

The values for the different particulars are tabulated under several forms of combination. One series of Tables gives the values arranged under the commonly used divisions of the year, and also under the meteorological divisions. Another series gives mean values for each day in the year: this series includes atmospheric temperature, dew-point temperature, atmospheric pressure, and fall of rain. The Tables of this series have double columns,—No. 1 column giving the *arithmetical mean* value belonging to each day, as computed simply on the whole of the years during which the

observations were carried on; so that each value is the mean of sixteen; and these means are reduced to diurnal means (correction being made for diurnal variation); and the daily values are corrected for index error. No. 2 column gives the mean values *proper* to the individual days throughout the year: these *proper values* are deduced from the *arithmetical means* by an arithmetical calculation which distributes the weight of the individual values in column 1, so as to produce series of regularly increasing and decreasing amount, but does not alter, in any degree, the sum-total of the 365 values. The process of converting rough lines into smooth lines is simple, both in principle and in practice: the main principle may be explained in a few words, by supposing the values for three consecutive days to be respectively 60, 50, 58: in which case the mean of the three, viz. 56, would be more relied upon as the proper value for the second of the three days than 50; but, in order to obtain what the author considers a safe result, the principle must be carried out with a wider range of action than this; and, with the range adopted in the construction of these Tables, very smooth curves are obtained throughout the year. The Tables for wind-direction have a twofold arrangement: the circle of the compass is divided into quadrants, of which the cardinal points are the limits; and also into four semicircles, of which cardinal points are the limits: the limits thus adopted are minutely accurate, because, in the original record, if the direction was in the smallest degree on the north side of east, it was then entered as E. by N.; and so also with either side of each cardinal point; and it very rarely occurred that the direction could not be ascertained to be on one side or the other of a cardinal point: those entries which did specify a cardinal point were distributed equally between the two quadrants which the cardinal point separated.

Diagrams are included in the work, which represent the *proper* daily progression of the following subjects, viz., atmospheric and dew-point temperatures, atmospheric and air and vapour pressures, fall of rain, cloud, directions of wind. The diagrams, with the exception of those for wind, give curves for the meteorological particulars in connexion with curves for the sun's declination; the latter curves thus constitute one uniform standard for appreciating the position and progression of each of the meteorological lines.

[A copy of this book is in the Library.]

X. *Fourth Meteorological Report of* Professor James P. Espy*. 4to. pp. 240, with 70 maps. 1854.

Professor Espy commences his report by giving a list of meteorological observers in the United States, and describing the meteo-

* It may not be generally known that Professor Espy has recently died.—H. S. E.

rological charts given in the work. By collating the meteorological journals at his disposal, and examining the charts, amounting to 1800 printed and unprinted, he has been able to eliminate the following generalizations:—

1. The rain and snow storms, and even the moderate rains and snows, travel from the W. towards the E., in the United States, during the months of November, December, January, February, and March, which are the only months to which these generalizations apply.

2. The storms are accompanied with a depression of the barometer near the central line of the storm, and a rise of the barometer in the front and rear.

3. This central line of minimum pressure is generally of great length from N. to S., and moves side foremost towards the E.

4. This line is sometimes nearly straight, but generally curved, and most frequently with its convex side towards the E.

5. The velocity of this line is such that it travels from the Mississippi to the Connecticut River in about 24 hours, and from the Connecticut to St. John's, Newfoundland, in nearly the same time, or about 36 miles an hour.

6. When the barometer falls suddenly in the western part of New England, it rises at the same time in the valley of the Mississippi, and also at St. John's, Newfoundland.

7. In great storms the wind, for several hundred miles on both sides of the line of minimum pressure, blows towards that line, directly or obliquely.

8. The force of the wind is in proportion to the suddenness and greatness of the depression of the barometer.

9. In all great and sudden depressions of the barometer, there is much rain or snow; and in all sudden and great rains or snows, there is a great depression of the barometer near the centre of the storm, and rise beyond its borders.

10. Many storms are of great and unknown length from N. to S., reaching beyond our observers on the Gulf of Mexico and on the northern lakes; while their E. and W. diameter is comparatively small. The storms therefore move side foremost.

11. Most storms commence in the "far west," beyond our most western observers; but some commence in the United States.

12. When a storm commences in the United States, the line of minimum pressure does not come from the "far west," but commences with the storm and travels with it towards the eastward.

13. There is generally a lull of wind at the line of minimum pressure, and sometimes a calm.

14. When this line of minimum pressure passes an observer towards the E., the wind generally soon changes to the W., and the barometer begins to rise.

15. There is generally but little wind near the line of maximum pressure; and on each side of that line the winds are irregular, but tend outwards from that line.

16. The fluctuations of the barometer are generally greater in the northern than in the southern parts of the United States.

17. The fluctuations of the barometer are generally greater in the eastern than in the western parts of the United States.

18. In the northern parts of the United States the wind generally, in great storms, sets in from the N. of E., and terminates from the N. of W.

19. In the southern parts of the United States the wind generally sets in from the S. of E., and terminates from the S. of W.

20. During the passage of storms the wind generally changes from the eastward to the westward by the S., especially in the southern parts of the United States.

21. The northern part of the storm generally travels more rapidly towards the E. than the southern part.

22. During the high barometer on the day preceding the storm, it is generally clear and mild in temperature, especially if very cold weather preceded.

23. The temperature generally falls suddenly on the passage of the centre of great storms; so that sometimes, when a storm is in the middle of the United States, the lowest temperature of the month will be in the W. on the same day that the highest temperature is in the E.

Professor Espy states his belief that all the phenomena connected with storms are explained by the following theory:—

When the air in any locality acquires a higher temperature or a higher dew-point than that of surrounding regions, it is specifically lighter, and will ascend; in ascending, it comes under less pressure and expands; in expanding from diminished pressure, it grows colder—about a degree and a quarter for every hundred yards of ascent; in cooling as low as the dew-point (which it will do, when it rises as many hundred yards as the dew-point at the time is below the temperature of air in degrees of Fahrenheit), it will begin to condense its vapour into cloud; in condensing its vapour into water or cloud, it will evolve its latent caloric; this evolution of latent caloric will prevent the air from cooling so fast in its further ascent as it did in ascending below the base of the cloud now forming: the current of air, however, will continue to ascend, and grow colder about half as much as it would do if it had no vapour in it to condense; and when it has risen high enough to have condensed, by the cold of expansion from diminished pressure, one-hundredth of its weight of vapour, it will be about 48° less cold than it would have been if it had had no vapour to condense, nor latent caloric to give out,—that is, it will be about 48° warmer than the surrounding air at the same height; it will therefore (without making any allowance for the higher dew-point of the ascending current) be about one-tenth lighter than the surrounding colder air, and, of course, it will continue to ascend to the top of the atmosphere, spreading out in all directions above as it ascends, overlapping the air in all the surrounding regions in the vicinity of the storm, and thus, by increasing the weight of the air around, cause the barometer to rise on the outside of the

storm, and *fall* still more under the storm-cloud, by the outspreading of air above, thus leaving less ponderable matter near the centre of the upmoving column to press on the barometer below.

The barometer thus standing below the mean under the cloud in the central regions, and above the mean on the outside of the cloud, the air will blow on all sides *from without, inwards*, under the cloud. The air on coming under the cloud, being subjected to less pressure, will ascend and carry up the vapour it contains with it; and, as it ascends, will become colder by expansion from constantly diminishing pressure, and will begin to condense its vapour into cloud at the height indicated before, and thus the process of cloud-forming will go on. Now, it is known that the upper current of air in the United States moves constantly, from a known cause, towards the eastward, probably a little to the S. of E.; and as the upmoving column containing the cloud is chiefly in this upper current of air, it follows that the storm-cloud must move in the *same direction*. And over whatever region the storm-cloud appears, to that region will the wind blow below. Thus the wind must set in with a storm from some *eastern direction*; and, as the storm-cloud passes on towards the eastward, the wind must change to some *western direction*, and blow from that quarter till the end of the storm. These are the elements of Professor Espy's theory of storms, which, with the numerical results, are demonstrated proximately in his work on the 'Philosophy of Storms.'

The phenomena of tornados, hailstorms, and whirlwinds may all be explained by this theory; and whatever cause induces an upmoving column of air in a calm, saturated condition of the atmosphere produces rain.

The following is one of a number of letters and certificates bearing on the point:—

"Dear Sir,—Your request for a relation of my experiments upon your theory of storms is flattering. I answer it with pleasure. They were at first accidental, and afterwards intentional. I will describe both.

"In 1845 I was engaged in the public survey on the Atlantic coast of Florida. Some time in April (the time of the dry season there, which lasts up to June) I was running a township line between latitudes 26° and 27°, about five miles from the sea. The weather was oppressively warm that day; there was not air enough stirring to move an aspen-leaf. We found our line must pass through a saw-grass pond, containing about 500 acres. In ponds of this description the green grass at the top shoots up from five to six feet in height; and when the region has not for some years been swept clear by fires, the dead and dry growths of preceding seasons accumulate under the latest growth, and are often found there from two to four feet in depth. They are exceedingly inflammable. When lighted in dry weather, they burn with frightful rapidity and violence. Whenever, in our explorations, we came upon a place of this description. we could only pass our line by cutting away the lofty fresh grass, and wading (or rather wallowing) through the mud and the under rubbish. On the day

in question, we determined, as it was so hot, that, to save ourselves trouble, we would burn our way through. I had then no thought of your theory. In order to prevent the flames from running over the woods, through which we were obliged to pass, we communicated them at once to both sides of the spot we desired to open, that they might converge and combine in its centre, and not scatter laterally. In a very few minutes an awful blaze swept over the entire surface which we had marked out for our purpose. We then crossed our line. Ere we had proceeded over forty chains, a delightful breeze sprang up and cooled the atmosphere, and presently a refreshing shower sparkled in the bright rays of the sun. All this excited no further observation than that it had not rained before there for a long time. I myself did not observe any smoke, nor the formation of any cloud.

"Our work went on for some days without a repetition of our short cut at pioneering, some objection having been made when another burning was proposed, because the first one had rendered it difficult, after crossing the lines, to distinguish the white men from the negroes. At length, however, the pleasant breezes ceased, which had made the weather for a while endurable, and the still air and intense heat returned, and with them constant murmurs from the men, especially the negroes, whose duty it was to cut lines and mark trees. We were now on the confines of a saw-grass pond, and a much more formidable one than any we had yet encountered. Being surrounded by a cypress-swamp, we concluded that it had never yet been burned. My assistant, Captain Alexander Mackay, who was standing by my side, mentioned his having, in our late conflagration, observed the formation of a cloud at the apex of the smoke; he added that it had frequently since brought to his mind some account which he had read of Professor Espy's theory. He suggested that there could not be a better opportunity than this to put the theory to the test; and, being fond of a joke, he said he would like to astonish the superstitious negroes, and to make them believe that he could call together the clouds and bring down rain. So we determined to make the experiment.

"When our party were all gathered at the halting-place, complaints of the extreme heat went round, and all unanimously agreed that a more confined and oppressive day had never been known to them. To these complaints the usual wishes for a 'little breath of air' and 'a few drops of rain' succeeded. 'Cut through this pond,' exclaimed the captain, 'and I'll bring you more than a few drops of rain; I'll give you a plentiful shower, and a breeze, too, that shall wake you up. Come, boys, cut away; and when you've done, you shall wash off the dust in a cold bath from the skies!' They stared up and around. Not a cloud as large as a man's hand was to be seen, and they looked back at the captain with a good-natured grin of incredulity. 'Ho, ho! ha, ha!—captain make cloud out o' nuffin; he, he!—captain bring water all dis way from de sea! Ho, ho!—ha, ha!—he, he!' Whereupon the captain affected to be very indignant. To hasten his victory,

I ordered the grass to be set on fire. The flames soared forthwith above the tallest trees; a dense volume of smoke mounted up spirally; the grass soon disappeared; we crossed over. As the smoky column broke and the cloud began to form, the captain traced a large circle in the sand around him, and placed himself in its centre, making fantastic figures and forming cabalistic phrases out of broken French; still was the cloud unnoticed. All eyes were riveted upon the captain, who stood gazing at the earth, and shaping outlines of devils there. At this juncture came a roll of distant thunder. Every glance instantly turned upward; a cloud was spreading there. The thunders increased; the lightnings flashed more vividly; the knees of the negroes shook together with alarm; already was the rain descending, and in torrents, though the clear sky could be seen in all directions under the cloud. The captain, meanwhile, maintained his mystical attitude, and continued his wild and extraordinary evolutions. Some of the whites, who were in the secret of the hoax, fell upon their knees, and were imitated by the negroes, whose fears augmenting as the storm grew fiercer, with clasped hands fastened upon the captain a stare of awe and deprecation.

"We often fired the saw-grass marshes afterwards; and whenever there was no wind stirring, we were sure to get a shower; and I say, with perfect confidence, that we never had a shower in April or May at any other time. Sometimes, when there was a breeze, it would carry the smoke towards the horizon, where there would seem to be a fall of rain. (Signed) GEORGE MACKAY.

"P.S. I have lately been informed by A. H. Jones, United States Deputy-Surveyor, that he has performed a great many experiments in Florida, of a similar nature, with like success; and that for some years several farmers, who became acquainted with these experiments, have been in the habit of setting fire to the dry grass, at the time they plant their corn, to produce rain; and that they generally succeed, though (this being in the dry season) it is known that no rain would otherwise occur.—G. M."

Professor Espy also enters into particulars of rains caused by the burning of prairies, pine-forests, and fallows; and calls attention to Humboldt's statement, in his 'Views of Nature,' of the violent rains which usually accompany the termination of volcanic eruptions.

By means of an instrument which he invented—the nephelescope—Professor Espy made many experiments on the degree of cold produced, both in dry air and in moist, by sudden expansion from diminished pressure. His chief object in these experiments was to ascertain the difference of cold produced in moist and dry air for similar expansions and different dew-points, in which he completely succeeded. In the course of these experiments, he found that air, in contact with water in a closed vessel, will not saturate itself with water, or, if saturated, will cease to be so after the lapse of a few days; that vapour permeates air from a high to a low dew-point with extreme slowness, if, indeed, it permeates it at all; and that *vapour rises into the regions where clouds are*

formed only by being carried up by ascending currents of air containing it.

The manner in which up-moving currents of air carry vapour with them may be seen in the formation of cumuli during a hot summer's day, when their summits increase by the addition of thin films of cloud produced by the air immediately above the cloud being pushed up, and the cold of expansion from diminished pressure causing its temperature to sink below its own dew-point. Dissolving clouds frequently occasion strong winds at the surface of the earth: they are termed wind-clouds by the farmers in America.

When the sun is N. of the equator, in our summer, the centre of greatest heat is also N.; the air rises there, and the denser air coming from the N. of this line, to latitudes where the diurnal velocity of the surface of the earth is greater, appears as a N.E. trade-wind; for the same reason, the air moving towards the line of greatest heat from the equator occurs as a S.W. monsoon, as has been proved by the labours of Lieutenant Maury. At the meeting of these currents, there is an upward motion of the air: the consequent condensation and expansion cause the barometer to fall at the spot, and rise above the mean to the N. and S., thus accounting for the well-known fact, that the barometer stands on a mean about a quarter of an inch lower near the equator than it does on the outer edge of the trade-winds. The Canary Islands are situated near the northern border of the N.E. trade-winds; in the summer they are within the trades, and in the winter they are just beyond their northern border. The barometer stands higher at these islands than at the equator, and somewhat higher than in Spain. Its mean maximum is in the spring and autumn, about the time that the northern limit of the N.E. trade-wind is exactly at these islands. During the whole year the upper current at the top of the Peak of Teneriffe blows from the S.W. In the summer, while the wind below blows strong from the N.E., there is no rain. In the autumn, when the S.W. wind is about to commence below, it commences at Portugal before it commences at Madeira, and at Madeira before it commences at the Canaries. In the spring, when the wind changes to the N.E. trade, it commences at the Canaries before it commences at Madeira, which lies to the N. of them. *The air, then, as we would suppose from theory, is pushed out below, both towards the N. and S., from the northern border of the trades, where the barometer stands higher than it does either N. or S. of those limits.* The air on the outer border of the trade-winds is remarkably dry; and this, to some extent, contributes to the greater height of the barometer there. The upper trade at the equator carries very little vapour in it, as, before it rises over the equatorial regions to one-third of the height of the atmosphere, nearly all its vapour is condensed into cloud; and therefore, when it rises above the cloud and rolls off to higher latitudes, it carries with it but little vapour. In short, the air above does not carry so much vapour to high latitudes as the air below to low latitudes; and when it descends to the surface, it

appears very dry, as its capacity for vapour is greatly increased by the heat of compression. Cloud is never formed except in an up-moving current; for air coming downwards always becomes dryer: and if it be supposed that cold air on the same horizontal level should mingle with warm, so as to produce condensation of vapour, the evolution of latent caloric in this air would immediately diminish its specific gravity, and it would begin to ascend.

Wherever there is an up-moving column of air sufficient to form a large cloud, there is, of necessity, a down-moving current of air all around it; and where this current reaches, it is clear, if any clouds existed at first they are soon dissolved by the heat of compression. Were it not for this cause, there are large regions of the torrid zone which would be covered with eternal cloud.

In the ocean there are three belts where the barometer stands below the mean, with almost constant rain or snow,—one near the equator, one near the arctic circle, and one near the antarctic. These belts change their latitude some degrees with the seasons, following the sun.

XI. *Report of the Meteorological Department of the Board of Trade.* 1862. Royal 8vo. Report, pp. 68; Appendix, pp. 359. Eight plates.

THE Report consists of ten chapters, of which the first and the last two are for official and general purposes, the intermediate chapters being purely meteorological.

In Chapter I. the origin of this department is referred to; and a brief sketch is given of its progress up to the present time, special reference being made to the "forecasts" of weather. "Twenty reports are now received each morning (except Sundays) and ten each afternoon, besides five from the Continent. Double forecasts (*two* days in advance) are published, with the full tables (on which they *chiefly* depend), and are sent to six *daily* papers, to one weekly, to Lloyd's, to the Admiralty, and to the Horse-Guards, besides the Board of Trade." The methods pursued are not dependent on one *individual*; the assistant is versed in them, and is able to share their responsibility.

Mention is made of the improved class of instruments now supplied to Her Majesty's ships, and to the convenience and utility of the portable aneroids that have recently been produced; and "more than eight hundred merchant-ships have been supplied by Government with tested and reliable instruments, *lent* to them, besides charts and books given *gratis*."

Chapter IX. contains:—"*Arrangements in office.—Present and future duty.—Estimate of expense.*"—The number of the staff is ten: one gentleman takes the "specially scientific duties," and another the "general management in the office;" meteorological telegraphy, reductions and discussions are in the hands of other two; records,

stores, translation, are committed to two others; the instruments and optician's duties, to two others; and there are a couple of lads to carry out weather reports and telegrams, &c. The estimate for the meteorological observations for 1862–63 is £4600, of which £1240 is for salaries and £2000 for meteorological telegraphy; the rest for sundries.

Instruments, verified at Kew, are entrusted to the care of clerks of the Electric, the Magnetic, and the Submarine Telegraph Companies, who have "gradually and well acquired the duties asked for (then perfectly new), which are now continued with extremely creditable regularity and precision." Many of the instruments at these stations have been collected in from the mercantile marine. A reduction of one-third from the published rates is made in favour of meteorological telegrams.

"The Admiralty have directed the Coast-guard to co-operate, when practicable," in exhibiting the cautionary signals, in accordance with the instructions that may reach them from Admiral FitzRoy; by which eighty places of storm-warning have been added to fifty previously established.

Chapter X. is headed, "*Nature and extent of results attained.—Contemplated proceedings.—Report by marine department.—Conclusion.*"

Last summer, two Reports were required by the Treasury of the results of these "experiments in meteorological telegraphy." One was furnished by Mr. Babington, who has charge of the scientific duties of this department, under Admiral FitzRoy. This report was made monthly, "corrected by himself alone, and untouched by any other person." It is given in the Appendix, and occupies 266 pages, commencing in January 1861, and extending to February 27, 1862. The weather reports, as they have appeared in the daily papers, with their appended forecasts, are reprinted, commencing from July 31, 1861; and the weather that actually followed is also in each case given. Diagrams from self-registering barometers are given for the whole period.

"The second Report, by direction and arrangement of officers not in this branch-department, was begun in July" 1861; and is given in the Appendix. It occupies six pages, is dated February 12, 1862, and is signed by Mr. Farrer. The objects proposed are adverted to. Subsequently to the completion and frequent exhibition of the storm-signals, the sanction of Mr. Milner Gibson was had "to their being continued on Admiral FitzRoy's responsibility, though at the Government expense;" and a letter was written to the Admiralty, "stating that the signals were the signals of Admiral FitzRoy, and not of the Board of Trade; and that they were simply an experiment."

"A great extension of the weather predictions" has taken place, which leads to an increase in the aggregate expense; but, on the other hand, the expense of providing instruments and collecting observations is diminishing. Mr. Farrer could find good reasons for the expense incurred "in collecting and publishing the weather statistics;" but he adds, "for the expense (if any) incurred in pub-

lishing the daily predictions of weather, or storm-signals, I am unable to find reasons which convince myself." "I have always thought that the wise and philosophical plan would have been to make the predictions in the office, without publishing them, for a considerable period."

Mr. Farrer considers the essentials for warnings of real practical value to be—"1. They should be so generally, if not universally, true that sailors may be able to rely on them with some degree of certainty. 2. They should be precise in point of time. There is little use in telling a seaman of a storm which may happen at any time within a space of two or three days. By that time, his voyage, or the dangerous part of it, may be over. 3. They should give in many places, at any rate, the direction of the coming storm."

At each place where signals were hoisted, the Coast-Guard Officer, or Receiver of Wreck, was instructed to report to the Board of Trade, on a printed form, the state and direction of the wind at six hours' interval for seventy-two hours after the exhibition of each signal. It is added "that these reports are made at intervals of six hours, that they come from persons of different characters and positions, and that their correctness must depend on the attention and judgment of those who make them. They must, therefore, not be taken for more than they are worth, though there is reason for believing them generally trustworthy."

Of 413 warning-signals, 199 did not reach so high as a "*fresh gale*;" 214 did. Of these 214, 72 reached a "*strong gale*;" 50, a "*whole gale*;" 11, a "*storm*;" and 6, a "*hurricane*." Of the same 214 cases, 112 cases of "*fresh gale*" occurred within 12 hours; 35, within the second 12 hours; 21, within the third 12 hours; 20, within the fourth 12 hours; and 26, after the fourth 12 hours.

With respect to direction, out of 223 warnings, "there were 106 only in which the wind is reported as having agreed in any one point with the signal;" of these, 62 did not attain to a "fresh gale," leaving 44 in which the wind did so attain, and agree in any one point with the signal.

Other kind of evidence, Mr. Farrer says, of the value of the warnings may be furnished by Admiral FitzRoy. The public are interested, and the signals are popular; and it is "very unlikely that any one will object to the estimate increased as proposed." ......"But the Board of Trade are bound to know what ground they are standing on;"......"because, though the work and credit are Admiral FitzRoy's," the Government sanction, pay, and are responsible.

Admiral FitzRoy gives his reasons for accepting with hesitation all the returns from which the above-named data are deduced; because "noting at definite six-hourly periods *could not* have given a correct report of wind and weather during even one day." Some of the reports are vague and wanting in detail, "apparently written off by persons to whom the subject was new." Letters

in reply, addressed to Mr. Farrer from various quarters, in general approval of the system, are given.

Many other matters are contained in this volume, to which our limited space will not allow us to refer.

[The volume is in the Library.]

XII. *Board of Trade Publications.*

The Third Report from the Liverpool Compass Committee to the Board of Trade, 1857–1860 (folio, pp. 131, 18 plates, various woodcuts, 1862), has just been circulated through the "Meteorological Department." It is described as the "Third and Final Report on the Magnetism of Iron Ships."

The First and Second Reports were published together in 1857, pp. 72, 30 plates, and woodcuts. These Reports are in the Library, as are also the chief of the following, which have either been published by, or circulated through, this Department:—

Icebergs in the Southern Ocean. By J. T. Towson. 8vo. 16 pp. one plate. January 1859.

Weather-Book Instructions. Folio, pp. 19, one plate.

Passage Table and Sailing Directions. 8vo. pp. 98. February 1859.

Swinging Ship for Deviation. 8vo. pp. 19. Second edition. 1859.

Notes on Meteorology. 8vo. pp. 35. 1859.

Barometer Manual. 8vo. pp. 48, woodcuts. Fifth edition. 1861.

Translation from Dutch Pamphlets on Herring Fisheries. 8vo. pp. 26. 1858.

Other books and pamphlets have been published by the Meteorological Department, the majority of which have been presented to the Society, and are in the Library.

A complete list is given by Admiral FitzRoy in the Report, at p. 338. It gives the date, name of publication, shape, number of pages, number of copies printed for sale and distributed, number distributed by the Department.

The list contains, also, the particulars of Maury's works, supplied by the American Government; among which are 17,100 wind and current charts, of which 8950 have been issued.

XIII. MANUAL OF HYDROLOGY: containing—I. *Hydraulic and other Tables.*—II. *Rivers, Flow of Water, Springs, Wells, and Percolation.*—III. *Tides, Estuaries, and Tidal Rivers.*—IV. *Rain-fall and Evaporation.* By NATHANIEL BEARDMORE, Civil Engineer. 8vo. pp. 384, 20 plates. March 19, 1862.

THE work now laid before the public by our President arose out of a small treatise, called 'Hydraulic Tables,' published in May 1850, a second and more extended edition of which was called for in September 1851, and which was soon out of print. The author preferred improving the work to reprinting; and the intervening eleven years have been more or less occupied in collecting data for this, which is, in fact, a new work, and not merely a new and expanded edition of the original. He refers in his Preface to the difficulty experienced a few years since by the young engineer in acquiring information on the many questions included in this branch of knowledge,—the practical questions being in the custody of a few canal and water-works engineers, who "were not much disposed in olden times to communicate the practical experience acquired by the hard labour of years."

The volume is essentially a book of Tables, with the necessary descriptive letter-press interspersed.

"All quantities of water, in this work, are given in cubic feet per minute.

"All velocities of water are given in lineal feet per minute.

"All measures of water are given in feet.

"All fall or surface-slope of water is given in inches per mile.

"All rain-fall and evaporation in inches of depth.

"All foreign measures have been converted into English, in expressing formulæ and in the reproduction or compilation of tables from the works of continental authors."

The First Division contains 42 Tables, many of which are subdivided, preceded by 30 pages of letter-press explaining the use of the Tables. Besides the Tables purely technical, are others that form an essential part of meteorological science; as, for instance, —Pressure of mercury and water per square inch and per square foot, with their equivalent columns,—Flood-discharges per minute for different amounts of rain-fall per diem, from 1 to 100 acres, and 1 to 10 square miles,—Mean discharge of annual rain at from 2 to 60 inches per annum, if flowing uniformly per minute and per diem, for one acre and one square mile,—Thermometric scales, tables for converting,—Marine surveying,......Velocity and pressure of wind,—Mountain-barometer. Six tables of corrections: —Logarithms of numbers,—Logarithmic sines and co-sines,—Natural sines, tangents, and secants.

Speaking of the mountain-barometer, the author says:—"In finding the relative summit-levels of different gaps or passes in a mountainous country, we have used it with great advantage over ground which, in fact, was inaccessible to ordinary instruments, which must be used step to step.

"*For finding the height in feet*, subtract the logarithm of the upper station from that of the lower, multiply by six, and remove the decimal point four places to the right; the result is the elevation in English feet, generally sufficiently accurate for purposes to which a mountain-barometer should be applied." For cases wherein perfect accuracy is required, the necessary corrections are pointed out, and the use of the tables given is explained. After which, the following remarks are made:—"Among the many varieties of mountain-barometers, the standard one with leathern bag is only fit for observations at a fixed station, because continual use and setting of a large floating surface of mercury to an index render the observations liable to errors. The closed-cistern barometer, commonly called Englefield, has the disadvantage of requiring a correction for the filling of the cistern, and we have also found these instruments sluggish in their action. The lightest and most philosophical instrument is Gay-Lussac's; it requires no correction for capillary attraction, and having only to be read by the difference of the two legs of the syphon, there is an equal chance of index-error in both readings.

"A great superiority of this instrument is, that a magazine can always be carried containing a number of spare tubes, and, on a breakage, a new one can be put into the frame, and the instrument rendered again fit for use in a few minutes.

"The mountain-barometer is always arranged to read to the 1000th part of an inch; but we have generally found that two successive readings cannot be taken nearer than the third part of this quantity, excepting, perhaps, in the Gay-Lussac, which can be inverted and read frequently, and not vary more than ·002 in the result. No one travelling now should be without an aneroid or manometer, both of which are very susceptible, and little liable to damage; of course these require continual reference to a standard barometer. Negretti and Zambra have recently contrived a standard mountain-barometer, without a bag, and otherwise superior to any instrument with which we have met" [*vide* Proceed. Meteor. Soc. No. 2. p. 113].

The name of the Second Division of the work is an index to its contents:—"Supply to wells and springs,—Supply of wells,—Flow of rivers and streams,—Estimate of floods,—Division of flood-waters from ordinary discharge,—On the River Lea,—Hinxworth experiments,—Tables of flow,—Rivers Arne, Rhone.—DESCRIPTION OF RIVERS:—The Loire,—The Rhine,—The River Po,—The Nile,—The Ganges,—Flow of metropolitan sewers and water-supply,—Tables of rivers." The plates, with which this section of the book is illustrated, refer to the rivers Po, Adige, Reno, Seine, Adda, Tiber, Nile, and Hoogly.

The Third Division includes—"On the tidal wave,—Tides of the Irish Sea,—Tides of the English Channel and North Sea.—*Tides of rivers and estuaries*:—The Thames,—The Waveney and Yare,—The Nene,—The Ouse,—The Humber,—The Tay,—The Tyne,—The Clyde,—The Mersey,—The Dee,—The Severn,—The

Avon,—The Seine,—The Gironde,—The Hoogly,—Tidal curves. —DOCKS IN GREAT BRITAIN :—Port of London,—River Mersey, —General Table of Dimensions of Docks in the United Kingdom."

The following extracts have reference to the fen-lands, of which a large area is at this moment flooded, in consequence of the destruction of the Middle-Level outfall sluice. "In the early part of this century, fen-lands to the extent of at least 200,000 acres, drained by this river [the Nene], were entirely water-logged in moderately wet seasons. In the past forty years, embankments have been improved and extended; great drains have been cut through the embanked lands, with direct outfalls on the Ouse, Nene, and Welland; more recently, steam has been applied to Whittlesea Mere and other low parts; and, consequently, at present there are no low countries more free from hurtful presence of waters than the great delta forming the outfalls of the Nene, Ouse, and Welland rivers. The great original source of all these improvements has been in the new deep water-courses through the old wandering channels and shallow sea-banks forming the debatable ground where flood-waters and the tide fought for possession." Further on we find :—

"The attempts which have been made to improve the river [Nene], through and above Wisbeach, have never yet been properly completed. This is as much from pecuniary difficulties as from defective engineering; for an enormous area of land, which should have been more naturally drained by the Nene, with an advantage of 5 feet fall, is now carried by the Middle-Level drainage into the Ouse." Then again :—

"The present Nene and Ouse are essentially artificial rivers, and the tidal flow is maintained by embankments of expensive character, some portions of which date from the Roman era; but the more important and systematical banks have been made since A.D. 1639, which is the date of the Great Bedford Level Embankment. Modern work has been properly applied rather to deepening than embanking, except in those cases where the latter necessarily formed part of the work."

The Fourth Division contains:—"Remarks on rain-fall.—Comparison of rain-fall on the lee and windward side of mountain-ranges.—Rain-fall at different heights.—Tables of mountain rain-fall.—Comparison of rain-fall (at places named).—Table of flow from large districts.—Mountain rain-fall of the Indian Peninsula. —Distribution of rain.—Australasia—character of the rain-fall.—Intensity of rain-fall in Europe.—On evaporation.—Comparative rain-fall and evaporation.—Mean temperature in different latitudes.—Denmark—rain-fall.—Water-supply, &c.—Synopsis of rain-fall in Great Britain.—Monthly rain-fall, &c., in Great Britain. —Great Britain—distribution of rain.—Monthly rain-fall of Ireland.—Mountain rain-fall, Great Britain and India.—Rain-fall of India and the Colonies.—Rain-fall, evaporation and temperature. —"Great Britain—details of monthly rain-fall.—Annual rain-fall (Continent, &c.).—Annual rain-fall, N. America, Russia."

Rain-fall and evaporation are discussed, not as meteorological, but as engineering questions. The Tables generally give each month's rain-fall; but for Great Britain and the colonies, in many cases, the greatest fall for one day, and the evaporation, are given. The years are divided into three parts, of four months each—the winter, spring, and summer divisions. This gives the rainy seasons in these sea-board latitudes in better arrangement than in months. "A wet November and December are not unusually followed by a dry January and February, and *vice versâ*." The mere amount of monthly rain-fall does not indicate the amount probably available for streams: heavy rain is the element required. The author has given Tables with total rain-fall and heavy rain in juxtaposition. He has called 0·3 in. in 24 hours a "heavy rain;" but he adds, "whether so small a fall as three-tenths of an inch will influence the flow, must depend on the season and previous state of rains. In September or October, in a dry year in these latitudes, it takes an inch of rain repeated twice in one week materially to affect streams, unless the country is precipitous and hilly."

Having noted "that, *cæteris paribus*, the rain-fall increases as we rise up the slope of a mountain," and that "it is much to be desired that the law could be ascertained which would give an approximation to the increase of rain-fall as we ascend hill country," and for which "it would be necessary to observe at a great number of stations thickly placed on given ranges of hills," the author remarks, "Probably a more just notion of the manner in which rain is collected in a hilly country will be found in the Table of actual flow from large districts, when we have the result of the rain-gauge, diminished by the amount of evaporation. We may here find a flow of from 6 to 9 inches in depth off a low country in a year, and from 51 to 111 inches off a district entirely mountainous, but of one-sixth the area of the former."

The author states that "the heaviest falls of rain in this country and in France are decidedly from thunder-storms, as likewise in S. Africa. The heaviest within our own knowledge fell in Westminster, Lambeth, and Vauxhall, on the 1st of August, 1846, to the amount of 4 inches in three hours. During half an hour of the time, the fall was composed of hail; and in less than one hour, flat, hollow roads were 2 feet deep in water, for neither side-drains nor gullies were competent to carry off one-tenth of the water that fell."

The engineer, for whom the author is now especially writing, regards evaporation more in reference to the quantity of water actually lost to him, whether by the mere evaporation of the meteorologist or by other causes conjointly; so that the observed rain-fall and the actual flow from large districts "throw considerable light on the loss which obtains from evaporation and vegetable absorption." "After rain, evaporation proceeds rapidly from a light soil, where the vegetation is scant and the surface exposed to the full action of the sun and wind; the surface soon becomes desiccated, and the amount of evaporation falls off. In a well-wooded district, although evaporation from the surface is less actual, yet

the rain which percolates the soil is arrested by the spongioles at the extremity of the roots of every plant, passes upwards by the process of endosmose, and is finally returned to the atmosphere from the surface of the leaves. This source of evaporation is much more constant than in the preceding instance, and is especially active in the spring and early summer months, during the period of foliation.

"In the autumnal months, the heated earth and water throw vapour into the atmosphere, having a tension greater than that which the temperature of the air can sustain; it condenses in fog, which deposits on every leaf and blade of grass, lading them with dew-drops: this is termed vaporization by the physicists."

The Tables on rain-fall and evaporation, herein referred to, occupy very nearly 90 pages.

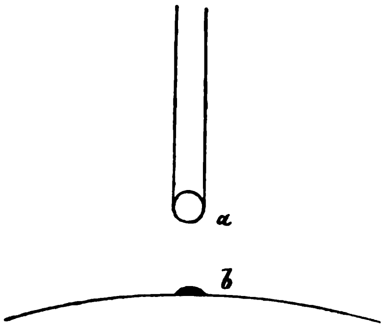
SUNDRY NOTES.

1. *Parhelion, or Mock-sun.*—An instance of the phenomena called parhelia, or mock-suns, rare in these latitudes, but familiar in arctic regions, was recently observed by the Rev. Charles Lane, of the Rectory, Wrotham, under the following circumstances:—

Early in the morning of Monday, January 27, 1862, Mr. Lane was driving up Wrotham Hill in the direction of the London, Chatham and Dover Railway (to the E. of Wrotham), when his attention was arrested by the remarkable state of the heavens. The sun appeared to have already risen, and to be about 3° above the horizon, showing a sickly face through a bank of fog; and from the northern limb of the sun there streamed upwards a broad ray of creamy light, resembling somewhat the tail of a comet, but, from its verticity, suggesting to Mr. Lane's mind the pillar of fire and cloud described in Exodus. This tail or pillar was of the breadth, throughout, of the sun's diameter, and its length about 9°, reaching to the edge of the bank of fog, between which and the zenith, the sky was gorgeously illuminated with colours, the varying tints of which were chiefly subordinate to a deep sapphire blue, alternating with horizontal streaks of gold.

Suspecting, from some former experiences, that he had a mock-sun before him, Mr. Lane noticed the time, which was 7.15 A.M.—too soon by 33 minutes, as he afterwards ascertained, for the sunrise of the almanac. He then desired his servant to watch the seeming sun, as probably an optical illusion which would soon pass away. The man did so, without at all understanding what deception there could be in the matter, till, very much to his astonishment, in half an hour, another sun (this time the real sun) began to show his unmistakeable rosy countenance, rising immediately under the mock-sun, or the place where it had just before been.

In the diagram, *a* is the mock-sun; *b*, the real sun rising over Wrotham Hill.



The ball of the mock-sun was well defined (its form distinctly globular) for fully fifteen minutes; it then began gradually to disappear; and it entirely vanished in the first beams of the real luminary of day, soon itself obscured by heavy clouds threatening rain, but none fell. The weather was unusually mild for the season. Thermometer, in the shade, about 50° Fahr.,—a great contrast to the temperature of the following week, when the thermometer fell 20°, and the country for five miles round Wrotham (February 8) was covered with snow.

The following is extracted from Dr. Fielding's register, taken at Tunbridge, about 10 miles from Wrotham:—

January 27.—*Barometer*, 9 A.M., reduced and corrected to sea-level, 30°·182.—*Degree of moisture*, 9 A.M., 88°.—*Temperature*, shade maximum, 45°·2; shade minimum, 34°; mean temperature, 39°·6.—*Wind*, 9 A.M., S.W.—*Rain-gauge*, 9 A.M., 0°·000.

February 8.—*Barometer*, 9 A.M., 30·484.—*Degree of moisture*, 9 A.M., 90°.—*Thermometer*, shade maximum, 32°·5; shade minimum, 11°·2; mean temperature, 21°·85.—*Wind*, 9 A.M., E.—*Rain-gauge*, 9 A.M., 0°·000.

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2. *Balloon Ascent at Wolverhampton*, 1862, March 22. — At the Meeting of the British Association this year at Manchester, a resolution was passed appointing the following members of the Royal Society a Balloon Committee:—Colonel Sykes, M.P. (chairman); the Right Hon. Lord Wrottesley, Sir David Brewster, Sir John Herschel, Bart., General Sabine, Dr. Lloyd, Admiral FitzRoy, Dr. Lee, Dr. Robinson, Mr. Glaisher, Professor Airy, Mr. Gassiot, Dr. Tyndall, and Professor W. A. Miller. Simultaneously with the appointment, £200 was placed at their disposal to carry out their investigations. This sum the Committee proposed to expend in making four ascents. It was resolved that the first two should be made from Wolverhampton, the first on Saturday, March 22, and the second on Tuesday, March 25. It was desired that an altitude of five miles should, if possible, be attained; but, on inquiry, it was found that there was,

in England, no balloon that would contain a sufficient quantity of gas to enable them to attain such an elevation. An arrangement was therefore made, in February, with Mr. Smith, the proprietor of Cremorne Gardens, to furnish his largest balloon for these experiments; and he engaged that it should contain 65,000 cubic feet. In pursuance of this contract, he sent the 'Royal Normandy' balloon, with the aëronaut, to Wolverhampton by midnight on Friday, March 21—too late to prepare for inflation that night, or examination of any kind.

At the request of the other Members of the Committee, Lord Wrottesley had made the necessary arrangements with the Wolverhampton Gas Company for a supply of gas; so that the balloon might be inflated early on the morning of Saturday, and the ascent be made by 11 o'clock; but, in consequence of the late arrival of the balloon, this could not take place. On Friday, Colonel Sykes, Chairman of the Committee, Dr. Lee, Mr. Glaisher, and Mr. Criswick, who was to be charged with the observations, all arrived at Wolverhampton. The space within the boundary of the Stafford Road Works of the gas company presented every facility for the inflating of the balloon very near to the gasometers. That convenient spot was therefore selected for the purpose; and it was designed to make the ascent, as stated above, before noon. Before that hour the members of the Committee whose names have been already mentioned were joined by Lord Wrottesley and Mr. W. Fairbairn (the President of the British Association), who had come from Manchester specially to witness the ascent, and by a few of the local gentry. That there might not be a crowd in the grounds, the intended ascent was kept almost a secret in Wolverhampton. All the preliminary operations were not completed till about half-past one o'clock; and at twenty minutes to two, the voyageurs ascended slowly and steadily, and amidst plaudits were wafted away upon a quiet breeze almost due N. After remaining for a few minutes at no great altitude, the balloon was lightened, and she quickly gained the height of, it was estimated, about a mile. By this time she had met with a counter current; and in thirteen minutes after her ascent she was lost sight of, sailing in a somewhat westerly direction, apparently towards Chester.

The arrangements at the gas-works were complete, and were carried out with admirable regularity by Mr. Thomas Proud, the company's engineer. The gas, which was made expressly for the Committee, was in abundant supply and of an excellent quality.

The objects sought to be attained are twofold:—first, to ascertain the law of the decrease of temperature in proportion to elevation; and, second, to determine the distribution of moisture throughout the atmosphere. For this purpose, a barometer, a pair of dry and wet thermometers free, a pair of dry and wet thermometers aspirated, and a Regnault's hygrometer were furnished, all made by Adie, and the same as those used by Mr. Welsh in his balloon ascents; in addition, there was an exceedingly delicate thermometer and an aneroid barometer by Negretti and Zambra; also tubes, some made by Casella, and some by Negretti and Zambra, exhausted of air, for the

purpose of collecting air at high elevations: there was also a magnet for the purpose of determining its time of vibration. Other atmospherical phenomena it was desired should be noticed, but to the two points, viz. temperature and humidity, the observer was to devote his principal attention. In order that the observations might be as complete as possible, as many as thirty observers—members of the British Meteorological Society—had engaged to make observations every ten minutes during the time that it was supposed the balloon would remain up. Notes were to be taken by these gentlemen at Bristol, Pembroke, Llandudno, Bangor, Llampeter, Harwarden, Manchester, Wakefield, Belvoir Castle, Grantham, Norwich, Diss, Oakham, Cambridge, Oxford, Hartwell, Gloucester, Worcester, and Wolverhampton. A height of not more than a mile had been attained, however, when the balloon proved utterly unworthy, and came down from sheer inanition, at a distance from Wolverhampton of not more than seven miles. The 'Royal Normandy' had scarcely got fairly up before the gas was found to be escaping from innumerable old rents. Previously to and also during the time of inflation, it was perceived that a large number of such defects had been covered with paper; and it was believed that the repairs were complete enough certainly for this voyage, but it does not appear that they were. Other defects had either been overlooked, or were only awaiting the circumstances which this inflation presented to become developed. The gas escaped rapidly from different parts of the machine, and the throwing out of all the ballast was insufficient to prevent the voyageurs and collapsing balloon from descending into a coppice at Chillington. Through the underwood in this coppice the machine dragged the car, its occupants, and its contents. When the voyageurs were once more on *terra firma*, such was the district in which they had been deposited that it was four hours before they could obtain a vehicle to remove the disabled balloon. Nearly all the instruments were necessarily broken.

The Committee at once communicated with Mr. Coxwell, and that gentleman proceeded to Wolverhampton with his balloon, the 'Mars.' It was, however, only in an incomplete state of repair. A consultation was then held between Lord Wrottesley, Colonel Sykes, M.P., Dr. Lee, James Glaisher, Esq., F.R.S., and Mr. Coxwell. The last-named gentleman expressed his readiness to construct a new balloon within two months that shall hold 80,000 to 90,000 cubic feet of gas, provided the Committee would avail themselves of it for their proposed ascents. The Committee accepted Mr. Coxwell's proposal in regard to the new balloon, and resolved to postpone their future investigation till the machine is made.

The 'Royal Normandy' was found from its dimensions to be able to contain very little more than 30,000 cubic feet, whilst its proprietors described it to contain 65,000; and the Committee felt grievously disappointed at the breaking of the contract in this respect; but it is impossible to speak too strongly in reprehension of the sending a balloon in such an incomplete state. We understand that Mr. Coxwell has made considerable progress in the new balloon.

3. Royal Institution of Great Britain.—*An Explanation of Meteorological Telegraphy, and its Basis, now under trial at the Board of Trade.* By Rear-Admiral FitzRoy, F.R.S. Pp. 12. Friday, March 28, 1862.

This was a Lecture delivered at one of the Friday-evening Meetings, in which Admiral FitzRoy explained and illustrated the principles by which he is guided in obtaining forecasts of the weather, and the arrangements he has made for turning them to useful account—subjects which have been more or less referred to in previous pages of the 'Proceedings of the British Meteorological Society,' when the attention of Members has been called in a cursory manner to the various Manuals and Reports that have been issued from the branch-department of Government over which the lecturer presides.

He gave a short sketch of the origin of this department and of its gradual advance. As an illustration of one result of the storm-warnings, he gives the following note:—

"At a recent meeting of the shareholders of the Great Western Docks, at Stonehouse, Plymouth, it was stated officially that the deficiency (in revenue) is to be attributed chiefly to the absence of vessels requiring the use of the graving-docks for the purpose of repairing the damage occasioned by storms and casualties at sea (February 24, 1862)."

He enters at some length into a description of air-currents, parallel, superposed, rotatory; the polar also, and the equatorial currents. He adverts to Dove's "wind-poles," N.E. and S.W. He cites Sir John Herschel's evidence:—

"The most important meteorological communication which could be telegraphed would be information, *just fresh received by telegraph*, of a cyclone actually in progress at a great distance, and making its way toward the locality. There is no doubt that the progress of a cyclone may be telegraphed, and might secure many a ship from danger by forewarning."

The arrangement is given under which the present daily forecasts are drawn up, and the limits within which the information concerning the probable coming weather is confined; and advice is given how prudently to use the forecasts themselves. In reply to questions,—"Are ships to remain waiting to avoid a gale that, after all, may not happen? Are fishermen and coasters to wait idle, and miss their opportunities?"—the lecturer says, "By no means. All that the cautionary signals imply is, 'Look out,' 'Be on your guard,' 'Notice your glasses and the signs of the weather,' 'The atmosphere is much disturbed.'"

A few remarkable cases, showing the value of the warnings, are given; and the lecturer concludes:—"No very dangerous storm need be anticipated, without more or less notice of its approach being generally communicated around the British Isles, and to those coasts which are likely to be most affected by its greatest strength."

PLATE I.

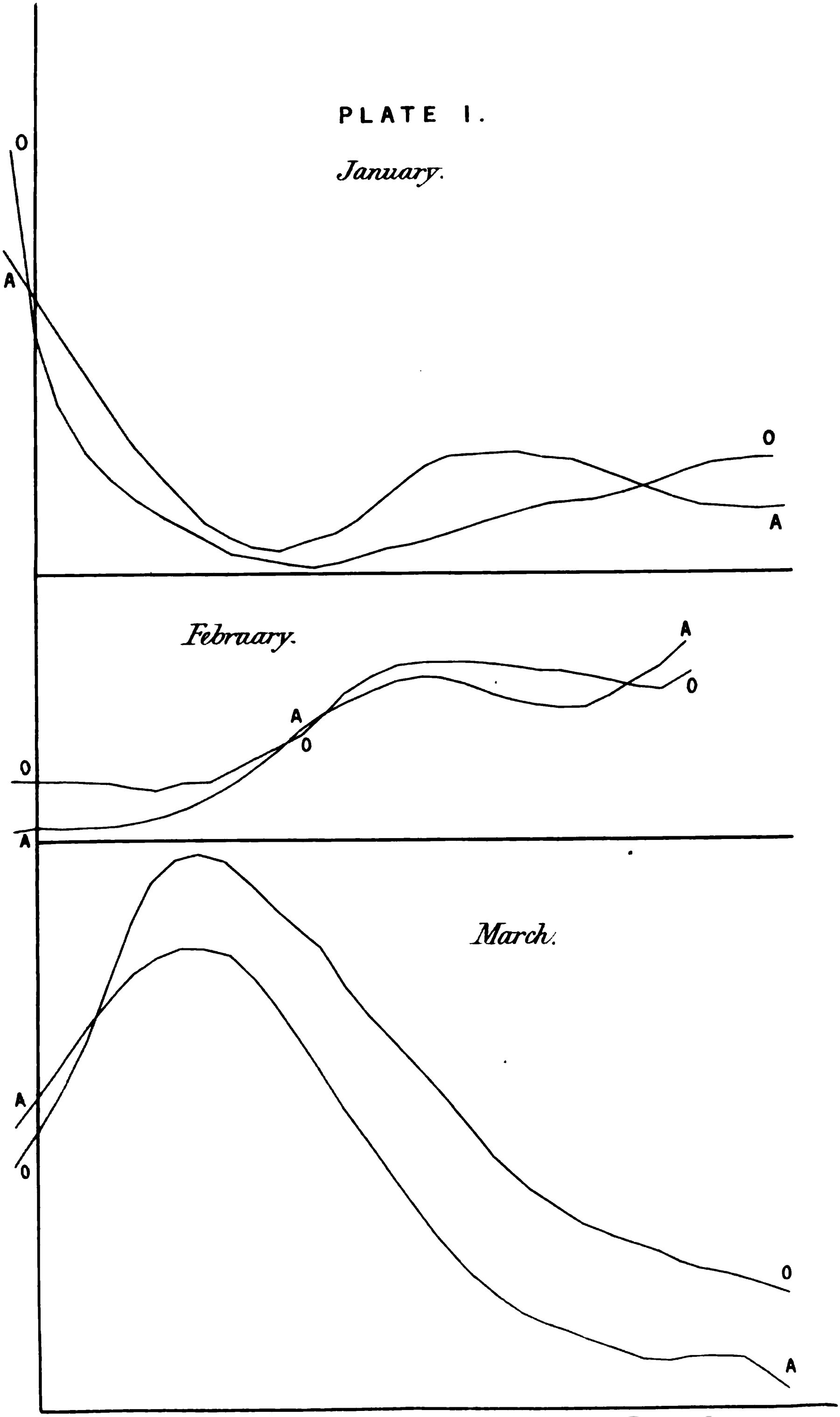

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PLATE II.

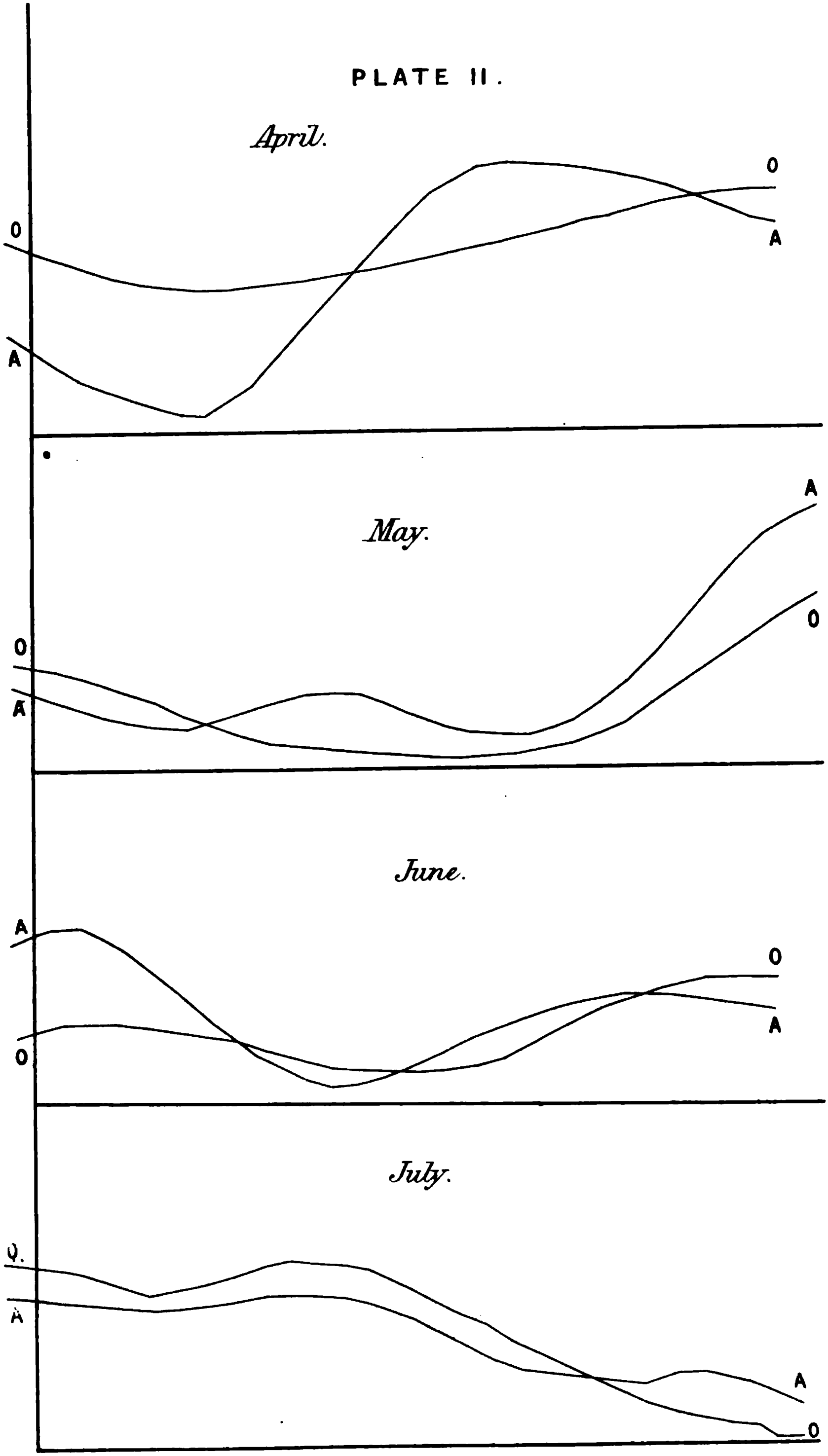

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PLATE III.

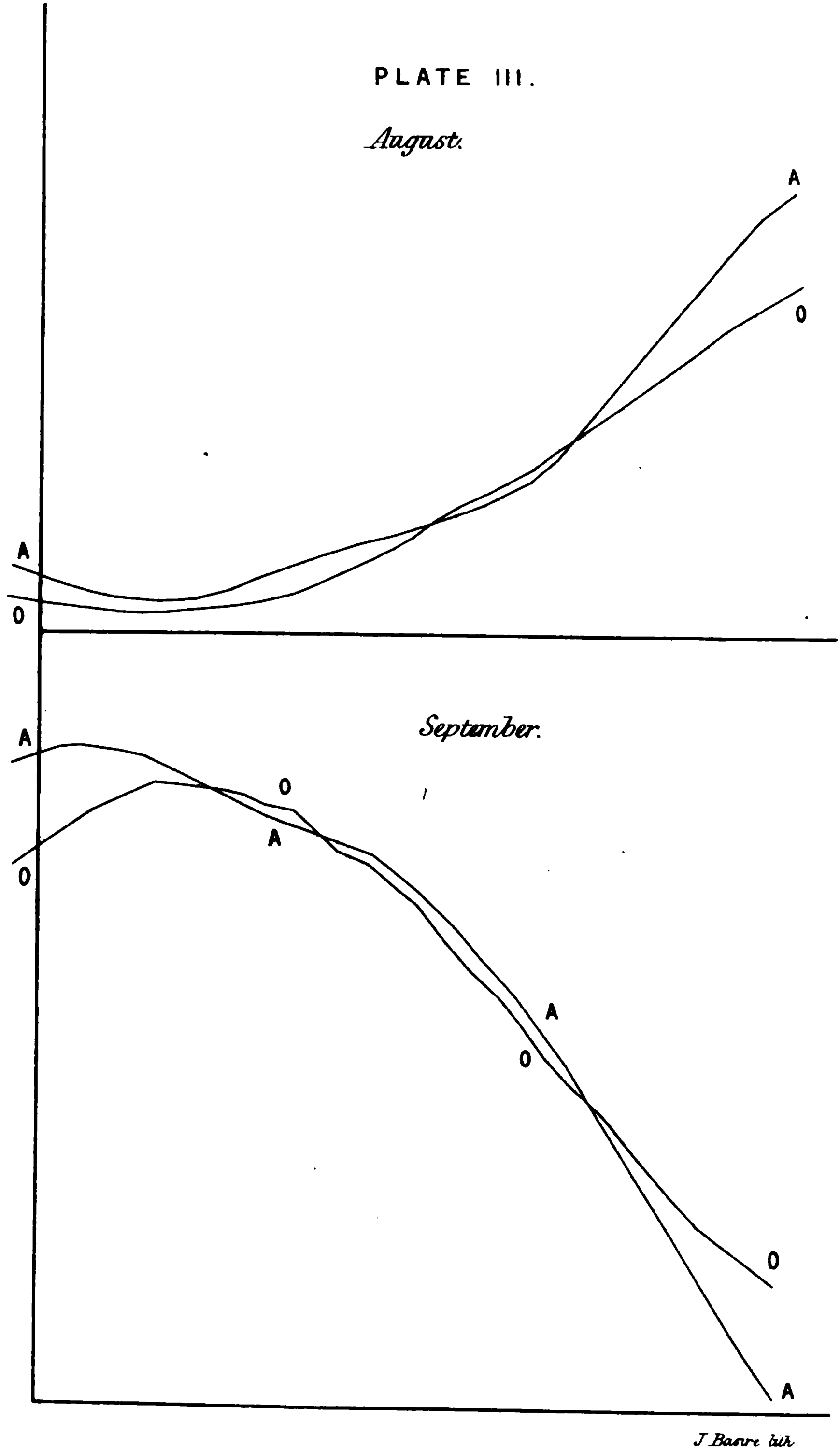

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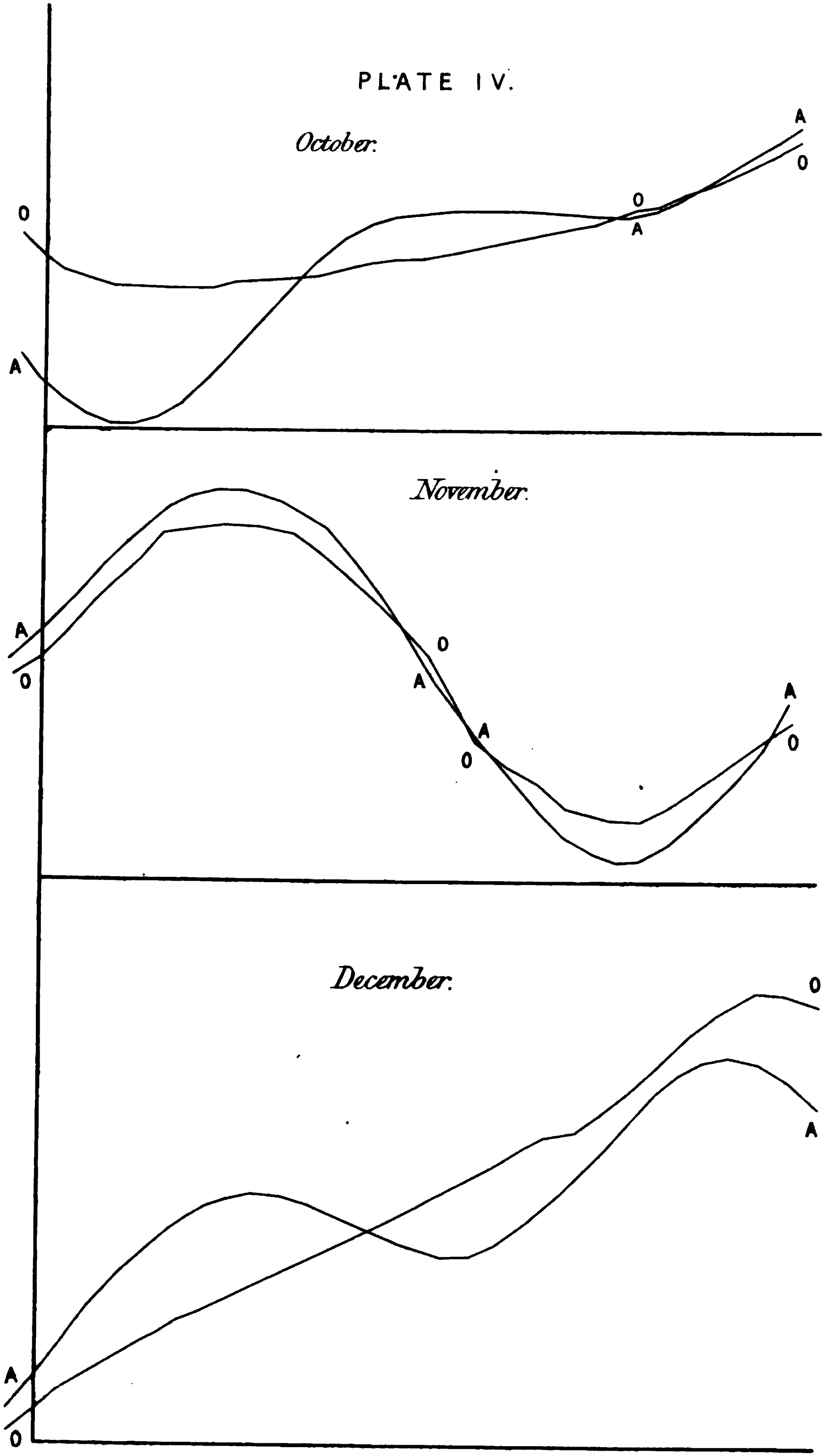
PLATE IV.



J. Basire lith.

[*Price Two Shillings.*]

Vol. I.] [No. 4.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

1862, JUNE 18.

CONTENTS.

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NOTICES TO MEMBERS.

*** The Report for the year ending 1861, June 12, is not quite ready.

With No. 4 of the 'Proceedings,' MEMBERS will receive the Catalogue of the Library, and a revised List of the Members of the Society.

Members, whose subscriptions remain to be sent in, are informed that the Treasurer's address is now, 57 Warren Street, Fitzroy Square, W.

[*Advertisements continued on the third page.*

BRITISH METEOROLOGICAL SOCIETY.

THIS Society was established in the year 1850, for the encouragement and promotion of Meteorological Science.

It consists of Members and Honorary Members.

Every person desirous of admission into the Society must be recommended by at least Three Members, of whom one must certify to his personal knowledge of such Candidate.

Candidates may be proposed at a Council Meeting; but the ballot must take place at an Ordinary Meeting. One Council or Ordinary Meeting must intervene between the nomination and the day of Election.

There is no Admission Fee. The Annual Contribution is £1; due on January 1. The Composition Fee is £10.

Persons eminent in Meteorological Science, not permanently residing in this country, are eligible as Honorary Members.

The Council of the Institution of Civil Engineers allow the Society to hold their Meetings at the Institution, No. 25 Great George Street, Westminster, S.W.; and to receive letters there.

Four Ordinary Meetings are held during the Session, which commences in October and terminates in June, at which Members can introduce their friends.

Papers accepted for reading at the Ordinary Meetings are published entire or in Abstract in the 'Proceedings' of the Society, which are issued as soon as possible after each Meeting, *and of which a copy is sent to every Member of the Society.* The 'Proceedings' also contain Notices of Books and Memoirs, descriptions of New Instruments, and other Meteorological News.

Daily observations are made, for the most part by Members of the Society, at about 60 different stations, which are forwarded monthly to one of the Secretaries, by whom each reading is examined and collated with readings made in adjacent stations. Their means are taken; and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of each 'Quarterly Meteorological Report' *is sent free to every Member of the Society.*

Copies of printed results of Meteorological Observations or Papers are from time to time received by the Society for distribution; and *are forwarded free to Members.*

The 'Proceedings' of the Society are published and sold by Taylor and Francis, Red Lion Court, Fleet Street, E.C.

The Society possess a Library, which is available to Members. The President, N. Beardmore, Esq., has kindly received it in his rooms, 30 Great George Street.

1862, March 1.

JAMES GLAISHER, F.R.S.,
Dartmouth Place, Blackheath, S.E.
CHARLES V. WALKER, F.R.S.,
Fernside, Redhill.
} *Secretaries.*

PROCEEDINGS

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N. BEARDMORE, Esq., C.E., F.R.A.S., President, in the Chair.

Professor Heinrich Wilhelm Dove, of Berlin; and
Professor Henri Victor Regnault, of Paris;
were balloted for and duly elected Honorary Members of the Society.

William Ford Barclay, Esq., Walthamstow, Essex;
G. J. Bosanquet, Esq., Broxbournbury, Herts;
J. W. Bosanquet, Esq., F.R.A.S., 73 Lombard Street, and Clay Hill, Enfield;
Beriah Botfield, Esq., 5 Grosvenor Square;
George Rowden Burnell, Esq., C.E., 14 Lincoln's Inn Fields;
Dr. Butter, Pembury Villa, Upper Norwood;
Samuel Canning, Esq., C.E., Abbey Wood, Kent;
John Coode, Esq., M.I.C.E., Weymouth;
Rev. John Ed. Cross, M.A. Oxon, Appleby Vicarage, near Brigg;
R. S. Culley, Esq., The Exchange, Bristol;
John Curtis, Esq., Sale Hall, near Manchester;
William Dolland, Esq., St. Paul's Churchyard;
George Clarisse Dobson, Esq., C.E., Holyhead Harbour;
William Foster, Esq., 16 Montague Square;

J. S. Fourdrinier, Esq., Secretary to the Electric Telegraph Company, Telegraph Street, London;
James Gibbs, Esq., Civil Engineer, Westminster;
James Heywood, Esq., F.R.S., F.G.S., F.S.A., 26 Kensington Palace Gardens, and Athenæum Club;
Nathaniel Holmes, Esq., 82 Park Road, Haverstock Hill;
Francis Loyd, Esq., Hoddesdon, Herts;
Thomas Mackereth, Esq., Eccles, near Manchester;
Admiral Manners, F.R.A.S., 8 Henrietta Street, Cavendish Square;
Julius Reuter, Esq., 19 Finsbury Square;
Thomas Henry Sanger, Esq., 23 College Green, Dublin;
J. L. Shuter, 33 Farringdon Street;
Balfour Stewart, Esq., M.A., F.R.S., Director of the Kew Observatory, Richmond, Surrey;
William Thompson, Esq., LL.D., F.R.S., Professor of Natural Philosophy in the University of Glasgow;
Henry Hill Treby, Esq., Goodamoor, Plympton, St. Mary, Devon;
Robert Harkness Twigg, Esq., C.E., King's Langley, Herts;
Sir Harry Verner, Bart., Claydon, Buckinghamshire;
Charles George Watson, M.K.Q.C.P.I. & L.M., M.R.C.S.I., late R.N., formerly Member of the Chester Natural History Society, 36 Cowgate, Peterborough;
William Godfrey Whitman, Esq., M.A., Kitlands, near Dorking;
Lieut. Allen Young, R.N.R., Riversdale, Twickenham;
were balloted for and duly elected Members of the Society.

XVIII. *On the Medical Meteorology of the Metropolis during the years* 1859, 1860, and 1861. By John W. Tripe, Esq., M.D., L.R.C.P.E., Medical Officer of Health for Hackney.

In my previous papers on the "Meteorology and Mortality of the Metropolis, during the years 1857 and 1858," read before this Society, and published in the Reports for 1858, p. 34, and 1859, p. 46, I discussed at considerable length the variations between the climate of Greenwich and that of the centre of London. I then showed, from the observations recorded by the Medical Officers of Health, that the mean temperature scarcely varied one-tenth of a degree in the year at the various stations, after due allowance had been made for difference of elevation; but that the diurnal range was much less in the central than at the outlying stations, such as Greenwich, Fulham, Hackney; that the night temperature does not fall in London proper so low as in the

outskirts, and that the air contained much less moisture and ozone in the central districts. I also ascertained, by the observations kept by myself at Hackney, and by Mr. Burge at Hammersmith, that air containing ozone became deozonized by passing over the metropolis. I have never detected ozone in the air at the east end of London.

Having premised these observations, I assume that the Greenwich returns of mean temperatures are sufficiently near those for the whole of London to be used without correction.

In order to compare mortality with temperature, it would be useless to class together the returns of corresponding weeks, as the death of an individual is often not registered for three or four days, and may be thus entered in the week after it occurred, and also because it is evident that a short time must elapse before the change of weather can modify disease or induce death. I have therefore assigned the mortality of one week to the temperature of the preceding week. In some cases it is evident that this period is too short, especially when the atmospheric variations have been unusually great; but, in the majority of instances, a careful examination of the Tables will show that this period, allowed in an ordinary season, is quite sufficient. The exceptions above mentioned will be pointed out in discussing the Tables; but I have not felt myself justified in placing the numbers in any other column than that to which they should be assigned according to the plan laid down for this and my previous papers. In accordance with that plan, I have formed nine columns of temperature, classing under the first all weeks in which the mean temperature was below 35°; in the next, those in which the mean temperature was 35° and upwards to 39°·9; and so on to the highest weekly mean temperature recorded, viz. 70°–75°. Out of the 156 weekly periods included in these three years, 9 instances occurred in which the mean temperature was below 35°; 16 in which it varied between 35° and 40; no less than 35 in which the temperature ranged between 40° and 45°; 23 in which it was 45° but below 50°; 20 in which it was 50°–55°; 28 in which it was 55°–60°; 19 in which it was 60°–65°; only 5 in which it reached 65°–70°; and 1 only in which it averaged 70°–75°.

During these years there were registered, within the Bills of Mortality for this metropolis, no less than 187,012 deaths from "all causes," or an average of 1199 weekly. Of these, 14,697 were assigned to the 9 weeks whose mean temperature was below 35°; 21,884 deaths to the column of 35°–40°; no

less than 45,126, or more than one-fourth, to the column of 40°–45°; 25,926 to that of 45°–50°; 21,411 to the column of 50°–55°; 28,805 to the next of 55°–60°; 21,236 to the column of 60°–65°; and 7967 deaths to the weeks which had a mean temperature in excess of 65°. As each of the columns includes a different number of weeks, these numbers will not show the relative fatality belonging to any individual group. I shall therefore give the average for each. The first in order of fatality was that group which had the lowest mean temperature, as the mean mortality was no less than 1633, the average of the whole being, as before stated, 1199. The next in order of fatality was that of the highest temperature, 70°–75°, when the deaths were 1605 for one week. The next group, 35°–40°, presents a very much smaller mean, viz. 1365, but still one which is considerably above the average. The next is the group of 40°–45°, where the mean is 1289; and the next group is that of 65°–70°, which is still above the average, as its mean was 1272. The remaining four groups, 45°–65°, were all below the average, the numbers being, for the group 45°–50°, 1127; for 60°–65°, 1118; for 50°–55°, 1070; and for the lowest, 55°–60°, 1028. These results are nearly identical with those obtained in my former papers, and agree precisely as regards the weeks which are the most healthy and most unhealthy.

The next and perhaps most satisfactory way will be to present the rate of death in each group, calculated not on the gross numbers, but on the means for each group. The order of fatality will of course be the same as that just stated, viz. greatest for the weeks below 45° and above 65°, and smallest for the others. In the group below 35°, the per-milleage was 142; in that of 70°–75°, 139; of 35°–40°, 119; of 40°–45°, 113; and of 65°–70°, 110; whilst of 45°–50°, it was only 98; of 60°–65°, 97; of 50°–55°, 93; of 55°–60°, it was only 89. The per-milleage therefore varied between 142, in the group below 35°, and 89 in that of 55°–60°,—a very great difference considering the large amount of sickness, as well as the number of deaths. The average of the five groups which present the greatest mortality is 125; whilst the average of the groups from 45°–65° is only 94.

An investigation, which I made some time since, as to the influence of temperature on various classes of disease, showed that although certain affections, such as those of the respiratory organs, scarlet fever, diarrhœa, and some few others, are differently affected by atmospheric changes, yet the majority increase almost at a fixed ratio with a diminution of temperature below a weekly mean of 40°,

or an elevation above 60°. Indeed, were it not that a low temperature diminishes the mortuary rate of diarrhœa and scarlet fever, whilst it increases that of diseases of the respiratory organs, and *vice versâ*, the number of deaths registered during cold weather would be greater even than it now is.

The practical lesson which these investigations teaches us is, that we should prevent, as much as possible, the prejudicial influences of extreme heat or cold, by adopting such a diet and dress as will best counteract their effects. It should also be especially remembered that the rate of death amongst the very young and the old is increased by cold in a greater proportion than amongst those who are in the prime of life.

The Mortality from diseases of the Respiratory Organs, exclusive of consumption, during the years 1859–61, was no less than 33,354, being at the rate of 10 deaths in each 56 from all causes. There were 4341 deaths for the 9 weeks in which the temperature was below 35°; 5310 deaths when the mean weekly temperature was between 35° and 40°; 9668 when the temperature was between 40° and 45°; 5115 when between 45° and 50°; 3075 when it ranged from 50° to 55°; 3423 between 55° and 60°; 1903 when between 60° and 65°; and 519 only in the 6 weeks having a temperature above 65°. The mean weekly mortality was 214; and there were 4 columns which had an average in excess of this number, viz., all those below 50°. It is very remarkable that, out of the 73 weeks included under the columns of 50°–75°, only two instances are to be found of a mortality in excess of the mean weekly death-rate.

Out of 1000 deaths from these diseases, supposing there had been an equal number of examples in each column, 258 belong to the column in which the temperature was below 35°; 178 to the column embracing the mean temperatures of 35°–40°; 148 to that corresponding with the temperature of 40°–45°; 119 to that of 45°–50°; 83 to the column of 50° and 55°; 65 to that of 55°–60°; 54 to the temperature of 60°–65°; only 45 deaths when it was between 65° and 70°; and 50 when above 70°. These results precisely correspond with what we might have expected from former investigations, although the difference between a mean of 258 deaths when the temperature was below 35°, and of only 45 deaths when it was above 65°, is larger than might have been expected. In one week, when the temperature of the preceding week had been 26°·4, the mortality from these diseases was no less than 702, whilst in one of the weeks in

which the temperature was above 65° the mortality was only 66. There are several apparent exceptions to the rule that the lowest temperatures cause the greatest mortality, but they are readily explained by reference to the temperature of the preceding weeks; for the mortality from these affections does not fall immediately on a slight or even a rapid change of temperature, when the previous cold weather has been of unusual duration or of excessive severity. Had it not been for this, the mean mortality of the column 40°–45° would not have been so great as 276 per week.

The Mortality from Fever varies far less than that of any other disease which will be considered in this paper, the highest per-centage having occurred in the week of highest mean temperature, and the lowest in the group of 55°–60°. The highest per-centage was 15·2, and the lowest 9·2. With the exception of this single week, the range varied between 9·2 and 12·2 per cent. The mortality from "fever" is extremely small, 4941 deaths only having been registered in the three years under consideration. In the years 1840–56 there were 36,277 cases of fever registered, or at the rate of 2134 per annum in a much smaller population than at present, against 1637 per annum for the years 1859–61. If the 2134 be corrected for increase of population, it will be about 2600 against 1637—a most enormous difference. The causes of this reduction in the mortuary rate of fever cannot be discussed here; but I may briefly state that, in my opinion, they are, the removal of nuisances and overcrowding under the supervision of the Medical Officers of Health; the more cleanly habits of the people, partly from better education; the diminished amount of drunkenness; the greater frequency of excursions into the country; the rise in wages; the diminished prices of necessaries, and consequent improved diet and clothing.

I feel assured that it is a great mistake to expect sanitary measures to extirpate fever or any other disease. It is almost certain that fever is to a great extent a preventible disease, but I do not believe it to be so in anything like the rate which sanguine sanitarians would have the public to believe. Indeed, it is somewhat remarkable that fever has of late years been very prevalent in the houses of the rich and middle classes, and has produced a large mortality amongst them. I have visited very many well-drained houses in which fever has occurred, and have in several instances detected bad smells, arising from accumulations of refuse, dead rats under the flooring, &c., but in many instances could not discover any cause for the attack.

The Mortality from Diarrhœa varies in its rate at different times of the year, far more than that of any other disease. Thus, the mean mortality for the weeks having a mean temperature below 35° was only 13; for the weeks having a temperature of 35°–40° it was 16; of 40°–45° and 45°–50° it was only 14; of 50°–55° it was 29; of 55°–60° it was 54; of 60°–65° it rose to 126; of 65°–70° it obtained the great fatality of 256, whilst in the solitary week of which the mean temperature was 70°–75° the enormous number of 415 deaths from diarrhœa was registered. The per-centages differ so little from these numbers that it is not necessary to enumerate them; but they will be found in the Tables appended. This enormous difference in the mortality is only in accordance with the results deduced from prior investigations. The smallest number of deaths registered in any week, during these three years, was 4, and the largest was 415, or more than 100 times the smallest number. As stated in a previous paper, the causes of this enormous difference are not known; for the exciting cause or causes may be brought into action by the increased temperature, or the excessive mortality may (though this is scarcely probable) be caused by the increased temperature itself. The total mortality from diarrhœa was 6853 during these three years.

I append a Table showing the per-centages of deaths from all the diseases considered in the paper; also another Table, from an unpublished essay, showing the mortality from certain diseases which vary in their rate of death at different seasons of the year.

This Table does not require many remarks. As regards the upper half, I would point out that I have given the mortality from cholera, 1st, during the whole period; 2nd, for the years 1849 and 1854, when it was epidemic; and 3rd, for the other years, when it was not epidemic. As regards the lower half of the Table, it must be carefully noted that the averages of highest and lowest are calculated from the actual returns, so that, if 100 deaths represented the smallest weekly average mortality, the highest would be that assigned to it in the Table. For instance, the lowest average mortality from small-pox occurred during these years in the 15th week, being represented by 100; the highest average occurred in the 1st week, and was represented by the number 180, or at the rate of 5 to 9; and so on for the other diseases.

Metropolis, for each week in the years 1859, 1860, and 1861.

TABLE I.—Mortality from "all causes," at different Temperatures.

	Below 35°.	35° to 40°.	40° to 45°.	45° to 50°.	50° to 55°.	55° to 60°.	60° to 65°.	65° to 70°.	70° to 75°.
	1548	1429	1338	1226	1057	1084	938	1400	1605
	1677	1380	1329	1174	1028	998	913	1419	......
	1500	1274	1243	1175	1058	970	1024	1337	......
	1442	1182	1156	1141	1111	1111	1226	1047	......
	1407	1307	1215	1067	1090	1092	1296	1159	......
	1707	1289	1201	1108	1087	1014	1118	......	......
	1707	1297	1126	1070	969	996	1217	......	......
	1926	1386	1207	1048	1064	910	902	......	......
	1783	1389	1233	1051	965	1004	1077	......	......
	......	1442	1304	1407	1016	1001	1092	......	......
	......	1454	1289	1116	1056	975	1043	......	......
	......	1563	1344	1026	1075	1015	1171	......	......
	......	1275	1397	1084	1008	919	1207	......	......
	......	1318	1611	1208	1049	975	1225	......	......
	......	1434	1708	1238	1237	1047	1172	......	......
	......	1424	1284	1226	1121	999	1257	......	......
	......	......	1268	1220	1108	1029	1127	......	......
	......	......	1205	1182	1147	937	1121	......	......
	......	......	1183	1240	1087	1018	1110	......	......
	......	......	1257	1251	1078	968	......	......	......
	......	......	1240	1248	......	926	......	......	......
	......	......	1459	1439	......	1237	......	......	......
	......	......	1328	1281	......	1069	......	......	......
	......	......	1279	......	......	1101	......	......	......
	......	......	1214	......	......	1106	......	......	......
	......	......	1236	......	......	1126	......	......	......
	......	......	1209	......	......	1113	......	......	......
	......	......	1210	......	......	1065	......	......	......
	......	......	1261	......	......	......	......	......	......
	......	......	1219	......	......	......	......	......	......
	......	......	1288	......	......	......	......	......	......
	......	......	1300	......	......	......	......	......	......
	......	......	1283	......	......	......	......	......	......
	......	......	1148	......	......	......	......	......	......
	......	......	1554	......	......	......	......	......	......
Totals.........	14697	21844	45126	25926	21411	28805	21236	6362	1605
Means	1633	1365	1289	1127	1070	1028	1118	1272	1605
Per-centages.	14·2	11·9	11·3	9·8	9·3	8·9	9·7	11·0	13·9

Metropolis, for each week in the years 1859, 1860, and 1861.

TABLE II.—Mortality from Diseases of the Respiratory Organs, at different Temperatures.

	Below 35°.	35° to 40°.	40° to 45°.	45° to 50°.	50° to 55°.	55° to 60°.	60° to 65°.	65° to 70°.	70° to 75°.
	430	322	323	218	153	119	111	92	93
	470	302	271	209	130	131	86	90	......
	420	241	258	217	98	98	96	70	......
	394	191	202	191	173	74	113	66	......
	348	314	244	190	190	78	67	108	......
	485	307	224	192	157	95	66	......	......
	547	357	201	154	115	80	71	......	......
	702	368	199	123	141	92	88	......	......
	545	389	233	179	108	142	139	......	......
	......	401	284	358	122	130	115	......	......
	......	415	279	211	144	90	124	......	......
	......	450	346	190	157	123	103	......	......
	......	314	387	207	170	107	100	......	......
	......	300	485	261	209	106	89	......	......
	......	309	476	246	220	103	111	......	......
	......	330	253	211	159	85	101	......	......
	......	......	240	214	146	123	108	......	......
	......	......	224	212	143	104	102	......	......
	......	......	270	241	171	120	113	......	......
	......	......	291	209	169	119	......	......	......
	......	......	291	213	......	121	......	......	......
	......	......	362	379	......	220	......	......	......
	......	......	291	290	......	169	......	......	......
	......	......	238	......	......	179	......	......	......
	......	......	214	......	......	134	......	......	......
	......	......	210	......	......	128	......	......	......
	......	......	209	......	......	169	......	......	......
	......	......	229	......	......	184	......	......	......
	......	......	219	......	......	......	......	......	......
	......	......	230	......	......	......	......	......	......
	......	......	247	......	......	......	......	......	......
	......	......	299	......	......	......	......	......	......
	......	......	267	......	......	......	......	......	......
	......	......	225	......	......	......	......	......	......
	......	......	447	......	......	......	......	......	......
Totals.........	4341	5310	9668	5115	3075	3423	1903	426	93
Means	482	332	276	222	154	122	100	85	93
Per-centages.	25·8	17·8	14·8	11·9	8·3	6·5	5·4	4·5	5·0

Metropolis, for each week in the years 1859, 1860, and 1861.

TABLE III.—Mortality from Fever, at different Temperatures.

	Below 35°.	35° to 40°.	40° to 45°.	45° to 50°.	50° to 55°.	55° to 60°.	60° to 65°.	65° to 70°.	70° to 75°.
	24	41	31	27	28	24	25	40	46
	37	39	45	25	42	34	29	29	......
	22	46	32	39	42	22	29	40	......
	22	36	26	29	34	30	36	49	......
	27	28	23	32	24	24	39	28	......
	27	38	26	43	30	44	37	......	......
	24	32	40	34	20	48	46	......	......
	26	35	32	26	27	42	40	......	......
	40	31	31	36	29	22	26	......	......
	......	29	41	32	26	15	31	......	......
	......	31	23	31	22	34	31	......	......
	......	41	33	24	25	22	30	......	......
	......	23	33	31	29	28	23	......	......
	......	34	42	21	24	25	22	......	......
	......	51	40	31	32	15	43	......	......
	......	51	33	21	30	22	34	......	......
	......	......	34	30	45	21	41	......	......
	......	......	24	25	53	16	21	......	......
	......	......	24	32	52	33	53	......	......
	......	......	18	18	47	24	......	......	......
	......	......	19	44	......	16	......	......	......
	......	......	17	62	......	29	......	......	......
	......	......	21	41	......	22	......	......	......
	......	......	26	......	......	32	......	......	......
	......	......	30	......	......	27	......	......	......
	......	......	28	......	......	31	......	......	......
	......	......	23	......	......	41	......	......	......
	......	......	24	......	......	36	......	......	......
	......	......	26	......	......	......	......	......	......
	......	......	25	......	......	......	......	......	......
	......	......	29	......	......	......	......	......	......
	......	......	19	......	......	......	......	......	......
	......	......	37	......	......	......	......	......	......
	......	......	59	......	......	......	......	......	......
	......	......	50	......	......	......	......	......	......
Totals.........	249	586	1064	734	661	779	636	186	46
Means	28	36	30	32	33	28	33	37	46
Per-centages.	9·2	11·9	9·9	10·6	10·9	9·2	10·9	12·2	15·2

Metropolis, for each week in the years 1859, 1860, and 1861.

TABLE IV.—Mortality from Diarrhœa, at different Temperatures.

	Below 35°	35° to 40°.	40° to 45°.	45° to 50°.	50° to 55°.	55° to 60°.	60° to 65°.	65° to 70°.	70° to 75°.
	9	11	6	6	13	7	6	264	415
	10	18	18	9	10	6	20	382	......
	14	18	10	11	61	34	58	312	......
	7	28	8	17	9	148	132	156	......
	21	13	15	6	11	82	296	167	......
	16	22	10	8	13	40	240	......	......
	11	7	4	4	11	34	215	......	......
	9	12	9	25	14	31	29	......	......
	18	13	14	11	22	18	26	......	......
	......	11	16	11	64	12	32	......	......
	......	9	8	10	46	12	61	......	......
	......	5	15	9	42	21	134	......	......
	......	23	15	34	32	32	200	......	......
	......	20	13	25	21	52	195	......	......
	......	19	16	12	16	65	177	......	......
	......	20	18	18	17	90	208	......	......
	......	......	7	15	68	87	183	......	......
	......	......	12	7	52	69	147	......	......
	......	......	15	15	35	91	137	......	......
	......	......	16	12	25	61	......	......	......
	......	......	11	24	......	60	......	......	......
	......	......	19	19	......	50	......	......	......
	......	......	23	12	......	12	......	......	......
	......	......	20	......	......	14	......	......	......
	......	......	17	......	......	87	......	......	......
	......	......	15	......	......	105	......	......	......
	......	......	21	......	......	54	......	......	......
	......	......	12	......	......	34	......	......	......
	......	......	17	......	......	......	......	......	......
	......	......	13	......	......	......	......	......	......
	......	......	16	......	......	......	......	......	......
	......	......	7	......	......	......	......	......	......
	......	......	16	......	......	......	......	......	......
	......	......	15	......	......	......	......	......	......
	......	......	12	......	......	......	......	......	......
Totals.........	115	257	479	320	582	1408	2496	1281	415
Means	13	16	14	14	29	54	126	256	415
Per-centages.	1·4	1·7	1·5	1·5	3·1	5·8	13·4	27·3	44·3

TABLE of Per-centages of Deaths in the Metropolis during the years 1859–61.

	Below 35°.	35° to 40°.	40° to 45°.	45° to 50°.	50° to 55°.	55° to 60°.	60° to 65°.	65° to 70°.	70° to 75°.
All causes	14·2	11·9	11·3	9·8	9·3	8·9	9·7	11·0	13·9
Respiratory organs	25·8	17·8	14·8	11·9	8·3	6·5	5·4	4·5	5·0
Fever	9·2	11·9	9·9	10·6	10·9	9·2	10·9	12·2	15·2
Diarrhœa	1·4	1·7	1·5	1·5	3·1	5·8	13·4	27·3	44·3

Extracted from an unpublished paper of mine:—

TABLES of Mortality from certain Epidemic and other Diseases. Per-centages of Deaths for the years 1840–56: 52 weeks in each year.

Number of deaths.	Diseases.	Spring. March, April, May.	Summer. June, July, August.	Autumn. September, October, November.	Winter. December, January, February.
14,257	Small-pox	22·9	23·9	23·3	29·9
20,676	Measles	21·7	24·9	24·5	28·9
33,451	Scarlet-fever	18·0	23·6	35·2	23·2
17,535	Hooping-cough	30·3	19·3	19·5	30·9 } ten
*	Bronchitis	22·9	11·9	19·6	45·6 } yrs.
36,277	Fever	23·4	23·7	27·7	25·3
29,308	Diarrhœa	8·5	41·9	39·7	9·9
27,489	Cholera, 1844–54	0·5	48·3	48·6	2·6
14,126	„ 1849	0·5	57·3	38·8	3·4
10,954	„ 1854	0·1	39·4	60·3	0·2
2,409	„ 1841–48, 1850–53	2·1	35·0	53·2	9·7

Calculated from the returns of the seventeen years, 1840–56.

	Weekly rate of death. Highest.	Weekly rate of death. Lowest.	Week of year when highest.	Week of year when lowest.
Small-pox	180	100	1st	15th
Measles	191	100	49th	36th
Scarlet-fever	236	100	41st	10th
Hooping-cough	267	100	9th	34th
Fever	137	100	50th	12th
Diarrhœa	1,237	100	33rd	19th
Cholera, 1844–54	203,800 or 2,038	100 } 1 }	36th	8th
„ 1849	2,026	1	36th	7th
„ 1854	2,050	0	36th	Several weeks, 1st, 5th, 8th, 10th.

* The total number of deaths from bronchitis has been mislaid; but the per-centages are correct.

XIX. *On the Luminosity of Phosphorus in connexion with Atmospheric conditions; and on the Magnetic Condition of Phosphorous Vapour.* By W. MOFFATT, Esq., M.D., F.R.A.S.

[Abstract.]

THE connexion between the luminosity of phosphorus and atmospheric conditions has had my constant attention for nearly three years; and the following Tables and remarks are from the daily observations of twelve months, viz., from April 1860 to April 1861.

If an ozone test-paper be exposed to the action of phosphorus, it becomes brown; and the brown colour is produced by the action of ozone, generated by the catalytic action of phosphorus upon moist air. Coloration takes place only when the phosphorus is luminous; and it is luminous or non-luminous according to the state of the weather.

By the following Tables it appears that ozone and luminous periods commence and terminate with exactly similar atmospheric conditions; in short, that the occurrence of ozone and the luminosity of phosphorus are peculiar to the south current, while the absence of ozone and the non-luminosity of phosphorus are with the north or polar current of the atmosphere. The diseases which take place at the commencement of ozone-periods occur also at the commencement of periods of phosphorescence.

Although the periods of luminosity of phosphorus and those of the maximum of temperature and humidity are coincident, it would appear that these conditions have no direct influence in causing phosphorescence; for in May 1860 the phosphorus was luminous every day with a mean temperature of 51°·3, and degree of humidity 74·0; while in June it was not once luminous with a mean temperature of 51°·7, and a degree of humidity of 86·0; and in December and January 1861 it was luminous on seventeen days with a mean temperature of 45°·1, and a degree of humidity 93·0. Phosphorus becomes luminous on the approach of storms; and phosphorescence increases with gales.

On the 12th of July, 1860, phosphorus became luminous; ozone reappeared with a period of decreasing readings of the barometer; and there was a gale. On the 5th of February, 1861, phosphorus became luminous, but continued so only for one night. Barometer readings decreased, with an increase of atmospheric ozone from 1 to 9.

The following Tables, as above stated, are from the results of the observations of twelve months.

TABLE I.

Barometer.		Temperature.		Humidity.		Direction of Wind.	
Increasing.	Decreasing.	Increasing.	Decreasing.	Increasing.	Decreasing.	North or Polar Points.	South or Equatorial Points.
Minimum of ozone.	Maximum of ozone.	Maximum of ozone.	Minimum of ozone.	Maximum of ozone.	Minimum of ozone.	Minimum of ozone.	Maximum of ozone.
Phosphorus		Phosphorus		Phosphorus		Phosphorus	
non-luminous.	luminous.	luminous.	non-luminous.	luminous.	non-luminous.	non-luminous.	luminous.
29·698 Mean.	29·555 Mean.	50°·3 Mean.	45°·0 Mean.	83·9 Mean.	81·2 Mean.	Phosphorus luminous 5 days in 100.	Phosphorus luminous 41 days in 100.

TABLE II.—Showing the commencement of Luminous Periods, with the commencement of Ozone Periods.

Periods.	Barometer.		Thermometer.		Humidity.		Ozone.		Wind.	
	Increasing.	Decreasing.	Increasing.	Decreasing.	Increasing.	Decreasing.	Absent.	Present.	North or Polar.	South or Equatorial.
296 ozone periods during ten years ...	8·1	91·1	64·5	35·5	56·7	43·0	...	...	28·0	64·7
12 periods of luminosity	1·0	99·0	99·0	1·0	66·3	33·3	...	100	...	100·0

TABLE III.—Showing the Termination of Luminous Periods, with the Termination of Ozone Periods.

Periods.	Barometer.		Thermometer.		Humidity.		Ozone.		Wind.	
	Increasing.	Decreasing.	Increasing.	Decreasing.	Increasing.	Decreasing.	Absent.	Present.	North or Polar.	South or Equatorial.
296 ozone periods	94·9	5·1	33·8	63·1	48·5	51·1	...	...	60·0	39·0
12 periods of luminosity	66·0	33·0	1·0	99·0	37·5	62·5	77·7	22·0	66·0	33·0

On March 1, 1862, phosphorus became luminous; ozone period commenced. March 27th, 1862, phosphorus became luminous; an ozone period commenced, and there was a period of decreasing readings of the barometer. From the last date to the 10th of April, the phosphorus continued luminous; ozone was observed every day, and ranged from 1 to 9, with the wind veering from S.E. to N.W. by way of S., and the barometer readings ranging from 28·974 to 30·020. The readings of the barometer increased to 30·158, the wind became N.E. in direction; ozone disappeared, and the phosphorus became *non*-phosphorescent. I have once only seen a period of luminosity of the phosphorus commence when the air was positively electric; and that was on the evening of the 17th of the present month (April 1862). The electric signs were positive on the 15th, 16th, and 17th; but on the 18th the sign was negative. On the evening of the 17th the phosphorus became luminous; the readings of the barometer decreased, and ozone increased from 3 to 9; and there was a gale from the S.W.

Take a piece of phosphorus, dry it, and cut it into a pyramidal form; place it upon a piece of clean cork; place them on a clean dry porcelain plate, upon which place a bell-glass. The glass I use is very thin, about fifteen inches high, and six in diameter. When the phosphorus is placed under such a bell-glass under favourable circumstances, a stream of vapour rises from it. The stream most frequently terminates in an inverted cone of rings, similar to those thrown off by phosphoretted hydrogen. At other times, it forms a beautiful parabolic curve,—the descending limb being of the same length as the ascending. This stream of vapour appears to possess magnetic properties. If a magnet (the one I use is of the horse-shoe form, and weighs about one ounce and a half; larger magnets seem to complicate movements) be presented to the side of the glass, the vapour is attracted to it, and it may be made to follow the magnet round the glass. Steel also, such as a bunch of keys, attracts it. The vapour also magnetizes steel needles. I suspend the needles by a thread of unspun silk, so that they are in contact with the stream of vapour. A fine steel needle thus suspended, so as to be in contact with the vapour, becomes magnetic; its north and south poles being attracted and repelled by the opposite poles of the magnet. Needles, that were magnetic while they were under the influence of the vapour, have now lost all signs of it. The magnetic properties of phosphorous vapour I discovered in the spring of 1860. Since then, I have performed the experiments, I may say, hundreds of times, and always with

the same results. Many gentlemen, scientific and non-scientific, have witnessed the experiments; and all were satisfied that the vapour was attracted by the magnet. There can be no doubt of the fact, whatever may be the cause. I thought it possible that the heat of the hand might rarify the air in the interior of the bell-glass, and thereby cause a leaning of the stream of vapour towards the magnet; but I have obtained the same results when the magnet (or steel) was fixed to a piece of wood, three feet in length.

It appears, then, that there is an intimate connexion between phosphorescence, atmospheric ozone, storms, and negative electricity; and as the ocean, and the air over it, often become phosphorescent before storms, and as ozone is always at its maximum with them, and magnets are disturbed by them, it is probable that there is an intimate connexion between phosphorescence, ozone, and terrestrial magnetism.

NOTE.—The following are the results of experiments performed to-day (June 15, 1862), which corroborate, I may say for the hundredth time, those I communicated to you twelve months ago.

The phosphorus was placed as in the other experiments. The same magnet and bunch of keys were placed for some time in the same apartment, that they might be of the same temperature as the air within the glass containing the phosphorus. The magnet was fixed to a piece of stick three feet in length, and applied to the side of the glass. The phosphorous vapour was immediately attracted to it. The bunch of keys was next applied, suspended to the same stick, and the result was the same. A thin piece of wood, two feet long, was next applied, and it gave no result; or rather, there was no apparent motion produced in the vapour.

In a former communication, I stated that I applied the magnet and keys suspended to a long piece of stick, to prevent the rarefaction within the glass, as the air being rarefied on one side would cause the stream of phosphorous vapour to lean to that side. That heat causes the vapour so to fall, or attracts it, is shown by the following experiments. The same piece of thin board, that I used in the former experiments, was heated and applied to the glass; the phosphorous vapour was immediately attracted to it. The board was applied to the *opposite* side of the glass, and the vapour was attracted to that. From these results, it appears that the leaning of the vapour to a heated body is not simply owing to the rarefaction of the air within the glass—that it is rather an attraction; and

this view is supported by the following experiment. The same piece of wood was cooled, and washed over with sulphuric ether. On applying it to the glass, the phosphorous vapour was *immediately repelled* to the other side of the glass, and then disappeared. In my paper on the "Luminosity of Phosphorus," I have shown, in a Table, that it ceases to be luminous with the prevalence of the polar or cold wind, and becomes luminous with the equatorial or warm wind. Phosphoric ozone is only formed when the phosphorus is luminous. The cold or polar current is the non-ozoniferous, and the equatorial is the ozoniferous.

XX. *Notes on an Aurora.*

Communicated by ALEX. S. HERSCHEL, Esq.

[Extracts.]

THESE extracts are taken from letters communicated to Mr. Herschel, to which is added an account of the same appearance extracted from the columns of the 'Staffordshire Advertiser.'

This account of the midland aurora of February 21st gives an accurate place to the arch, and further accounts may assign it good altitude:—

At 9 o'clock on the night of Friday, February 21st, at Thorney, about 7 miles from Lincoln and 14 from Newark, was seen a white cloud-like streak extending from E. to W. almost over the whole arch of the sky. It was in the form of an irregular arch, shaped like the bent sticks over a mole-trap, widest in the centre, and tapering gradually to the eastern horizon.

The night was very dark, and there were clouds on the eastern and western horizons—more on the western than on the eastern, and the white arch could be seen through a break in the clouds on the W. It was the same colour the whole length of the arch, the edges quite distinct; and in the widest part it was about the width of the space between the upper and undermost of the three great stars of Orion, $3\frac{1}{2}°$. It passed between Orion and the Pleiades, and went down by the Great Bear. The Pleiades, Orion, and the Bear had equal altitudes (of about 40°), 15° S. of W., 56° S. of W., and 40° N. of E. So the arch is to be understood to have arisen about 35° or 40° S. of W., to have passed upwards between Orion and the Pleiades to Capella, 20° from the zenith, due W. (which star

was seen through it), going down some way N. of the Bear to a point of the horizon just underneath him, 40° N. of E. The position of the pole-star was not noticed, so that a doubt remains as to the perfect accuracy of these inferences; but the theory is perhaps the best that can be fitted to the description.

I cannot recollect seeing any star through the arch; but some of our servants say they did. It was first seen at five minutes before 9, and by a quarter past it had disappeared—not moving off, but fading away. If it were the streak of light left by a meteor, the meteor must have been a *magnificent* one. When first seen about five minutes to 9, it was a complete arch. The person who first saw it did not see any meteor, nor does it appear that any one did. Another describes it as "going right up to the centre of the globe."

When I saw it, it had such a look of *durability* about it, that I was foolish enough to go in, and think I should come out again and find it still there; but it was gone in about a quarter of an hour, fading *gradually*, and at last rapidly. It went up about halfway between Orion and the Pleiades, I *think*, and a little nearer to Orion of the two; I mean, to the three great stars; but I have written to-day to some friends nigh to me, who saw it as they were returning home, one of whom *saw the star Capella in Auriga, through it*. It sprang from as nearly as possible where the sun had gone down, and went down in a rather north-easterly direction. The upright part of the arch was very equal in width; the edges not *even*, like a rainbow, but soft and a little waving: as far as I recollect, it did not begin to lessen till *after* it reached its greatest height, and then lessened gradually, the edges being more broken as it approached the eastern side of the horizon. It was a still night; there were clouds in the horizon, but the sky generally was clear. The Lincoln paper mentions the arch, and says that slight flashes of aurora were seen at the same time.

The perfect arch, extending from the S.E. horizon to the N.W., was visible for at least ten minutes; after that time a gap appeared in the middle, which gradually increased until both ends faded away. I believe the eastern end was the longest visible; but our western horizon is more interfered with, and we therefore naturally directed our observation chiefly to the clearer and lower eastern horizon. The impression on our minds is that the arch was slightly S. of the zenith. The arch did certainly extend beyond the Bear in an easterly direction; and at one time, when a perfect arch, it appeared resting its easternmost extremity

upon the hill which limits our view eastward. I remember well the position of the Great Bear, halfway to the zenith; but I dare not undertake to say *exactly* the inclination of the arch relative to the position of the Bear. It was certainly S. of the Great Bear, and in no way interfered with it. I dare say nothing about the position of the arch in relation to Orion or the Pleiades. There was no appearance of "crumpling up" before it disappeared. This arch was so beautifully and *equally* continuous from horizon to horizon for so long a time as to excite our greater curiosity, being so different from the usual aurora to our unpractised eyes. The time that the arch was entire, to our eyes, was certainly from 8.35 to 8.45. It may have been so longer; but this is *within* the limit, we feel *sure*.

On Friday evening last, February 21st, about 8.45, my attention was called to a peculiar appearance in the sky, and on looking out I was surprised to see a beautiful arch of about the breadth of the milky way, and having the same somewhat misty appearance, although rather brighter and decidedly more distinct in outline, extending across the heavens from E. to W., or more accurately from a point a little N. of E., overhead a little S. of the zenith, to another point a little S. of W. A fog was rising in the W., which speedily obscured that portion of the arch; and this fog extending rapidly, in twenty or twenty-five minutes the whole appearance was obliterated.

I presume it was an aurora borealis, or some other electrical phenomenon; but although I have frequently seen auroras, and occasionally very beautiful ones, in the north of England, I never before saw anything exactly like that above described. It appeared to be at a great height in the atmosphere; and I may add that, by watching the Pleiades and other stars through it, I ascertained that it had a motion in a southerly direction.

The short time during which I had the opportunity of noticing it prevents me from giving a more particular description.

XXI. *Weather Maps.*

By F. Galton, Esq., M.A., F.R.S., &c. &c.

Proofs of certain maps were exhibited by Mr. Galton, showing the state of the weather over Europe three times a day, in the month of December 1861.

By a method of symbols, the height of the barometer, temperature of the air, and evaporation, amount of cloud, rain, snow, and the direction and force of the wind, are simultaneously presented to the eye.

It will be remembered that Mr. Galton has intimated his intention of presenting copies of these maps, when completed, to those who contributed statistics for their formation.

XXII. *Results of Barometrical Observations at Exeter.* By H. S. Eaton, Esq., M.A., Librarian.

The following Tables, relating to the monthly range of the barometric pressure at Exeter, have been compiled principally from the register kept at the Rooms of the Devon and Exeter Institution, at the Cathedral Yard, Exeter.

From the commencement of the series up to the year 1852 the barometer employed (an ordinary mercurial barometer) was not of the best construction, and on this account no use has been made of the results in obtaining monthly averages. Fortunately, however, from 1848 to 1852 simultaneous observations were taken with a standard instrument at the residence of Dr. Shapter, near the Institution, which have afforded an equation, by which the readings of the instrument have been corrected as far as practicable; they have further been reduced to the temperature 32° and sea-level. In 1852 the instrument was replaced by Dr. Shapter's standard barometer.

For the first twelve years, observations were taken daily at 8 A.M., 2 P.M., and 10 P.M.; then, till 1852, at 9 A.M. and 9 P.M., and since that time at 9 A.M. and 3 P.M. From this it is obvious that, for the last few years especially, the observations were not made sufficiently often to determine the monthly range with anything like accuracy; I have accordingly had recourse to the registers kept by Dr. Shapter, Mr. Ellis, and Mr. Vicary, who gave every facility for their examination, and to whom my best thanks are due.

The monthly means since 1849 are from observations at 9 A.M. and 3 P.M., with a standard instrument; but they have not been continued for a sufficiently long period to determine the true monthly values.

The results of a rough set of observations for forty-seven years

give the following differences of the mean monthly values from the annual mean (see Plate V.) :—

	inch.
January	+0·009
February	+ ·008
March	− ·002
April	− ·034
May	+ ·003
June	+ ·024
July	+ ·035
August	+ ·025
September.........................	+ ·017
October.............................	− ·048
November..........................	− ·044
December..........................	+ ·002

It would be out of place here to enter into the question of the causes which operate in producing the phenomena of the barometer, which must be left for future consideration.

The general results to be learned from the Tables may be thus briefly stated :—

I. The average reading of the barometer declines from its maximum in July to its minimum at the end of October; from this time it rises till the middle of January, and again falls to a secondary minimum in April.

II. The average maximum in July is about 0·25 inch lower than in January; and the average minimum in the same month 0·41 inch higher than in December.

III. The absolute maximum in August is 0·44 inch lower than that in January; and the absolute minimum in July is 1·04 inch higher than in December.

Great depressions of the barometer are usually accompanied by violent storms of wind, thunder, and lightning; and are always preceded by a sudden increase of pressure.

The most notable depression that has occurred was towards the close of December 1821.

The movements of the barometer, reduced to the sea-level, were—

1821, December.

	8 A.M.	2 P.M.	10 P.M.
	inches.	inches.	inches.
On the 11th ...... at	......	30·36	......
„ 21st ...... „	29·18	29·42	29·56
„ 22nd ...... „	29·56	29·44	29·18
„ 23rd ...... „	29·15	29·26	29·34
„ 24th ...... „	28·94	28·67	28·29
„ 25th ...... „	28·57	28·60	28·65
„ 26th ...... „	28·46	28·67	28·87
„ 27th ...... „	28·97	29·03	29·12
„ 28th ...... „	28·55	28·15	28·18
„ 29th ...... „	28·57	28·87	29·13
„ 30th ...... „	29·29	29·38	29·77
„ 31st ...... „	30·07	30·13	30·17

And on January 19th, 1822, the barometer rose to 30·58 inches.

Again, in the violent tempest of rain, wind, and thunder on November 22nd and 23rd, 1824, the variations of the barometer were—

1824, November.

	8 A.M.	2 P.M.	10 P.M.
	inches.	inches.	inches.
On the 15th ...... at	......	......	30·38
„ 21st ...... „	29·49	29·46	29·43
„ 22nd ...... „	29·50	29·40	28·84
„ 23rd ...... „	28·26	28·65	28·96

And on January 9th, 1825, the barometer rose to its maximum, 30·98 inches.

In the summer months the barometer is always high and steady in hot weather, as in July 1818, when the temperature in the shade reached 95°; July 1825, June and July 1826, July 1835, June and August 1842, July 1852, June 1858 and July 1859.

In winter, a high barometer with sharp frost is followed by a low barometer when a thaw sets in; but if there is a severe frost when the barometer is low, an increase of pressure accompanies the thaw.

TABLE I.—Average Monthly Reading of the Barometer at Exeter, from observations at 9 A.M. and 3 P.M., reduced to 32° and sea-level.

Month.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	Average.
January	29.965	30.023	29.778	29.790	29.742	29.773	30.209	29.614	29.864	30.358	30.232	29.696	30.140	29.937
February	30.318	30.062	30.054	30.110	29.744	30.306	29.739	30.039	30.096	29.966	30.018	30.110	29.816	30.029
March	30.107	30.225	29.762	30.267	29.961	30.363	29.735	30.153	29.894	29.990	30.039	29.886	29.835	30.009
April	29.683	29.720	29.899	30.101	29.919	30.165	30.141	29.760	29.808	29.942	29.806	29.993	30.150	29.930
May	29.927	29.878	30.072	29.949	29.917	29.841	29.864	29.840	29.946	29.956	29.973	29.928	30.105	29.938
June	30.031	30.077	30.076	29.723	29.915	29.914	30.033	30.080	30.017	30.106	29.970	29.779	29.954	29.975
July	29.975	30.094	29.900	30.027	29.922	29.976	29.930	30.033	30.061	29.981	30.132	30.030	29.782	29.988
August	30.010	29.982	30.086	29.829	29.977	30.094	30.044	29.921	30.025	30.030	30.014	29.762	30.078	29.989
September	29.894	30.099	30.212	29.942	30.035	30.196	30.146	29.843	29.954	30.038	29.920	29.933	29.918	30.010
October	29.894	29.896	29.921	29.877	29.693	29.912	29.648	30.138	29.856	30.021	29.700	30.027	29.993	29.891
November	29.893	29.963	30.049	29.593	30.084	29.934	30.038	30.135	30.099	29.894	29.986	29.839	29.778	29.945
December	29.972	30.100	30.323	29.735	29.952	30.071	29.896	29.846	30.310	29.944	29.799	29.663	30.124	29.980

TABLE II.—Maximum and Minimum Readings of the Devon and Exeter Institution, Cathedral

Year.	January.		February.		March.		April.		May.		June.	
	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
1817.	30·65	28·59	30·70	29·72	30·69	29·12	30·66	29·98	30·33	29·29	30·40	29·29
1818.	30·59	29·03	30·35	29·02	30·50	28·58	30·47	29·18	30·40	29·41	30·40	29·79
1819.	30·61	29·14	30·26	29·26	30·39	29·25	30·31	29·21	30·30	29·53	30·37	29·57
1820.	30·81	29·02	30·43	29·59	30·48	29·05	30·59	29·20	30·39	29·26	30·51	29·61
1821.	30·87	29·09	30·88	29·25	30·45	29·04	30·29	29·27	30·39	29·27	30·44	29·73
1822.	30·57	29·36	30·79	29·36	30·61	29·65	30·52	29·32	30·40	29·37	30·33	29·77
1823.	30·27	29·08	30·36	28·67	30·53	29·05	30·54	29·16	30·49	29·39	30·43	29·36
1824.	30·73	28·99	30·63	29·06	30·44	29·15	30·53	29·25	30·68	29·53	30·43	29·34
1825.	30·98	29·61	30·67	29·66	30·70	29·26	30·54	29·29	30·45	29·66	30·43	29·53
1826.	30·59	29·59	30·56	29·36	30·47	29·50	30·44	29·30	30·37	29·73	30·51	29·93
1827.	30·43	29·51	30·66	29·59	30·39	28·80	30·43	29·47	30·26	29·33	30·37	29·65
1828.	30·56	29·24	30·60	28·92	30·45	29·16	30·39	29·19	30·39	29·23	30·40	29·45
1829.	30·43	29·06	30·63	29·06	30·39	29·25	30·16	28·74	30·50	29·65	30·43	29·46
1830.	30·70	29·29	30·42	29·49	30·67	29·52	30·26	29·30	30·38	29·39	30·17	29·41
1831.	30·70	29·03	30·50	29·10	30·52	29·28	30·52	29·11	30·31	29·49	30·28	29·75
1832.	30·56	29·32	30·66	29·31	30·39	29·44	30·58	29·43	30·53	29·33	30·43	29·49
1833.	30·70	29·41	30·73	29·06	30·41	29·25	30·35	29·03	30·51	29·45	30·39	29·43
1834.	30·52	28·96	30·59	29·78	30·60	29·61	30·59	29·28	30·53	29·45	30·39	29·55
1835.	30·82	29·32	30·64	29·16	30·67	29·00	30·59	29·59	30·25	29·53	30·43	29·39
1836.	30·73	29·26	30·56	28·91	30·40	28·55	30·49	29·08	30·63	29·81	30·34	29·59
1837.	30·66	29·33	30·39	29·26	30·55	29·35	30·49	29·45	30·43	29·68	30·40	29·55
1838.	30·38	29·36	30·46	28·56	30·59	29·02	30·39	29·14	30·40	29·51	30·33	29·57
1839.	30·70	29·28	30·60	29·41	30·15	29·41	30·54	29·49	30·28	29·45	30·36	29·43
1840.	30·58	29·10	30·60	28·36	30·72	29·90	30·47	29·60	30·45	29·43	30·31	29·79
1841.	30·52	28·99	30·49	29·03	30·51	29·32	30·21	29·36	30·43	29·33	30·47	29·49
1842.	30·60	29·22	30·60	29·16	30·46	28·87	30·42	29·28	30·46	29·36	30·39	29·68
1843.	30·59	28·30	30·09	28·90	30·45	29·37	30·16	29·40	30·25	29·40	30·23	29·25
1844.	30·51	29·34	30·36	28·69	30·52	29·32	30·58	29·61	30·45	29·88	30·30	29·72
1845.	30·36	28·93	30·43	29·49	30·52	29·58	30·38	29·01	30·37	29·50	30·43	29·35
1846.	30·68	28·88	30·48	29·43	30·69	29·28	30·40	29·12	30·39	28·97	30·38	29·46
1847.	30·36	29·06	30·36	29·46	30·59	29·45	30·11	29·36	30·55	29·41	30·55	29·53
1848.	30·35	29·27	30·49	28·48	30·30	28·77	30·12	29·24	30·37	29·35	30·18	29·26
1849.	30·64	29·02	30·90	29·32	30·71	29·23	30·30	29·26	30·29	29·32	30·26	29·69
1850.	30·61	29·48	30·49	29·05	30·69	29·40	30·42	29·01	30·32	29·40	30·41	29·52
1851.	30·41	29·07	30·51	29·28	30·49	28·70	30·24	29·45	30·51	29·58	30·49	29·55
1852.	30·43	29·11	30·71	29·34	30·81	29·23	30·43	29·61	30·34	29·64	30·09	29·26
1853.	30·32	29·02	30·25	28·96	30·32	29·34	30·45	29·30	30·18	29·55	30·21	29·62
1854.	30·60	28·74	30·79	29·68	30·77	29·86	30·62	29·43	30·32	29·18	30·24	29·60
1855.	30·66	29·41	30·14	29·30	30·53	28·93	30·56	29·41	30·15	29·45	30·42	29·26
1856.	30·73	28·99	30·60	29·59	30·69	29·79	30·33	29·20	30·30	29·47	30·38	29·58
1857.	30·43	29·03	30·60	29·40	30·61	29·15	30·41	29·02	30·30	29·33	30·41	29·53
1858.	30·75	29·88	30·36	29·58	30·59	29·08	30·43	29·23	30·54	29·16	30·44	29·85
1859.	30·88	29·32	30·71	29·29	30·49	29·17	30·30	28·99	30·25	29·68	30·25	29·57
1860.	30·38	28·73	30·68	29·36	30·62	28·80	30·47	29·02	30·44	29·40	30·33	29·08
1861.	30·56	29·40	30·73	29·08	30·53	29·21	30·51	29·61	30·51	29·51	30·23	29·58

Barometer at Exeter, from observations taken at the Yard, reduced to 32° and sea-level.

July.		August.		September.		October.		November.		December.		Year.
max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	
30·19	29·45	30·22	28·98	30·33	29·37	30·46	29·36	30·67	29·41	30·29	28·75	1817.
30·38	29·82	30·34	29·82	30·41	29·27	30·41	29·44	30·49	29·45	30·69	29·39	1818.
30·30	29·36	30·39	29·25	30·55	29·60	30·46	29·49	30·22	29·37	30·33	29·31	1819.
30·35	29·44	30·37	29·58	30·45	29·59	30·67	28·82	30·38	29·52	30·47	29·45	1820.
30·39	29·62	30·26	29·64	30·35	29·60	30·44	29·13	30·40	29·32	30·35	28·13	1821.
30·32	29·47	30·32	29·54	30·33	29·33	30·21	29·27	30·41	29·30	30·60	29·10	1822.
30·19	29·64	30·36	29·56	30·44	29·15	30·54	28·98	30·67	29·59	30·65	29·19	1823.
30·59	29·72	30·44	29·73	30·36	29·33	30·36	28·79	30·37	28·25	30·58	29·12	1824.
30·39	29·86	30·43	29·08	30·37	29·51	30·62	29·15	30·45	28·85	30·23	29·05	1825.
30·34	29·69	30·38	29·60	30·33	29·39	30·31	29·49	30·55	29·08	30·67	29·35	1826.
30·49	29·72	30·47	29·39	30·40	29·51	30·44	29·04	30·53	29·43	30·69	29·25	1827.
30·09	29·39	30·34	29·28	30·57	29·46	30·49	29·34	30·40	29·21	30·42	29·20	1828.
30·29	29·34	30·30	29·42	30·28	29·11	30·52	29·56	30·50	29·65	30·65	29·65	1829.
30·32	29·42	30·31	29·42	30·39	29·27	30·59	29·87	30·45	29·18	30·55	28·90	1830.
30·36	29·64	30·36	29·64	30·33	29·45	30·48	29·17	30·62	29·39	30·52	28·86	1831.
30·47	29·80	30·35	29·22	30·59	29·71	30·44	29·34	30·48	29·55	30·59	29·60	1832.
30·49	29·68	30·44	29·36	30·53	29·29	30·29	29·29	30·41	29·09	30·31	29·41	1833.
30·32	29·62	30·22	29·62	30·53	29·50	30·74	29·58	30·55	29·39	30·71	29·47	1834.
30·25	29·78	30·39	29·52	30·21	28·98	30·44	29·04	30·50	29·10	30·65	29·37	1835.
30·50	29·55	30·32	29·64	30·28	29·31	30·50	28·96	30·21	28·85	30·77	29·13	1836.
30·32	29·32	30·34	29·40	30·34	29·16	30·72	29·42	30·45	29·19	30·50	29·35	1837.
30·34	29·60	30·32	29·34	30·57	29·27	30·44	29·18	30·45	28·61	30·71	29·28	1838.
30·39	29·29	30·40	29·15	30·20	29·07	30·42	29·36	30·35	29·17	30·42	29·10	1839.
30·36	29·58	30·32	29·29	30·30	28·83	30·60	29·22	30·47	28·62	30·72	29·22	1840.
30·25	29·17	30·36	29·55	30·15	29·23	30·07	28·88	30·49	28·89	30·25	28·93	1841.
30·46	29·69	30·48	29·68	30·33	29·39	30·54	29·00	30·58	28·85	30·60	29·42	1842.
30·35	29·70	30·34	29·40	30·59	29·63	30·38	29·10	30·50	29·29	30·65	29·75	1843.
30·34	29·49	30·32	29·35	30·43	29·75	30·30	28·99	30·41	29·00	30·32	29·28	1844.
30·32	29·57	30·39	29·22	30·35	29·43	30·62	29·36	30·45	29·18	30·57	28·85	1845.
30·28	29·29	30·30	29·62	30·48	29·40	30·34	28·96	30·52	29·27	30·62	28·69	1846.
30·35	29·76	30·42	29·50	30·29	29·43	30·39	29·42	30·51	28·98	30·45	28·57	1847.
30·50	29·36	30·15	29·49	30·45	29·34	30·17	29·30	30·57	29·13	30·36	29·01	1848.
30·40	29·50	30·41	29·65	30·58	29·06	30·69	29·11	30·39	29·17	30·65	29·13	1849.
30·26	29·68	30·40	29·66	30·52	29·42	30·49	29·16	30·43	28·76	30·68	29·10	1850.
30·22	29·51	30·40	29·80	30·60	29·41	30·45	29·01	30·57	29·52	30·59	29·60	1851.
30·19	29·80	30·36	28·87	30·52	29·12	30·55	29·05	30·29	28·86	30·29	29·06	1852.
30·35	29·35	30·33	29·19	30·45	29·22	30·16	28·91	30·68	29·72	30·50	29·19	1853.
30·26	29·65	30·54	29·70	30·46	29·75	30·62	29·03	30·60	29·02	30·63	29·15	1854.
30·27	29·59	30·37	29·68	30·54	29·48	30·20	29·18	30·30	29·56	30·33	29·05	1855.
30·31	29·58	30·26	29·07	30·33	28·83	30·52	29·39	30·66	29·54	30·61	28·96	1856.
30·40	29·68	30·34	29·73	30·45	29·50	30·30	28·80	30·73	29·35	30·70	29·69	1857.
30·30	29·56	30·43	29·66	30·62	29·53	30·63	29·40	30·57	28·94	30·36	29·28	1858.
30·39	29·71	30·40	29·70	30·45	29·50	30·24	28·74	30·72	28·93	30·47	28·53	1859.
30·43	29·61	30·14	29·37	30·38	29·47	30·48	29·50	30·51	29·33	30·30	28·76	1860.
30·31	29·27	30·35	29·67	30·27	29·23	30·34	29·28	30·59	29·16	30·50	29·22	1861.

TABLE III.—Range of the Barometer.

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
1817.	2·06	·98	1·57	·68	1·04	1·11	·74	1·24	·96	1·10	1·26	1·54	2·11
1818.	1·56	1·33	1·92	1·29	·99	·61	·56	·52	1·14	·97	1·04	1·30	2·11
1819.	1·47	1·00	1·14	1·10	·77	·80	·94	1·14	·95	·97	·85	1·02	1·47
1820.	1·79	·84	1·43	1·39	1·13	·90	·91	·79	·86	1·85	·86	1·02	1·99
1821.	1·78	1·63	1·41	1·02	1·12	·71	·77	·62	·75	1·31	1·08	2·22	2·75
1822.	1·21	1·43	·96	1·20	1·03	·56	·85	·78	1·00	·94	1·11	1·50	1·69
1823.	1·19	1·69	1·48	1·38	1·10	1·07	·55	·80	1·29	1·56	1·08	1·46	2·00
1824.	1·74	1·57	1·29	1·28	1·15	1·09	·87	·71	1·03	1·57	2·12	1·46	2·48
1825.	1·37	1·01	1·44	1·25	·79	·90	·53	1·35	·86	1·47	1·60	1·18	2·13
1826.	1·00	1·20	·97	1·14	·64	·58	·65	·78	·94	·82	1·47	1·32	1·59
1827.	·92	1·07	1·59	·96	·93	·72	·77	1·08	·89	1·40	1·10	1·44	1·89
1828.	1·32	1·68	1·29	1·20	1·16	·95	·70	1·06	1·11	1·15	1·19	1·22	1·68
1829.	1·37	1·57	1·14	1·42	·85	·97	·95	·88	1·17	·96	·85	1·00	1·91
1830.	1·41	·93	1·15	·96	·99	·76	·90	·89	1·12	·72	1·27	1·65	1·80
1831.	1·67	1·40	1·24	1·41	·82	·53	·72	·72	·88	1·31	1·23	1·66	1·84
1832.	1·24	1·35	·95	1·15	1·20	·94	·67	1·13	·88	1·10	·93	·99	1·44
1833.	1·29	1·67	1·16	1·32	1·06	·96	·81	1·08	1·24	1·00	1·32	·90	1·70
1834.	1·56	·81	·99	1·31	1·08	·84	·70	·60	1·03	1·16	1·16	1·24	1·78
1835.	1·50	1·48	1·67	1·00	·72	1·04	·47	·87	1·23	1·40	1·40	1·28	1·84
1836.	1·47	1·65	1·85	1·41	·82	·75	·95	·68	·97	1·54	1·36	1·64	2·22
1837.	1·33	1·13	1·20	1·04	·75	·85	1·00	·94	1·18	1·30	1·26	1·15	1·56
1838.	1·02	1·90	1·57	1·25	·89	·76	·74	·98	1·30	1·26	1·84	1·43	2·15
1839.	1·42	1·19	·74	1·05	·83	·93	1·10	1·25	1·13	1·06	1·18	1·32	1·63
1840.	1·48	2·24	·82	·87	1·02	·52	·78	1·03	1·47	1·38	1·85	1·50	2·36
1841.	1·53	1·46	1·19	·85	1·10	·98	1·08	·81	·92	1·19	1·60	1·32	1·64
1842.	1·38	1·44	1·59	1·14	1·10	·71	·77	·80	·94	1·54	1·73	1·18	1·75
1843.	2·29	1·19	1·08	·76	·85	·98	·65	·94	·96	1·28	1·21	·90	2·35
1844.	1·17	1·67	1·20	·97	·57	·58	·85	·97	·68	1·31	1·41	1·04	1·89
1845.	1·43	·94	·94	1·37	·87	1·08	·75	1·17	·92	1·26	1·27	1·72	1·77
1846.	1·80	1·05	1·41	1·28	1·42	·92	·99	·68	1·08	1·38	1·25	1·93	2·00
1847.	1·30	·90	1·14	·75	1·14	1·02	·59	·92	·86	·97	1·53	1·88	2·02
1848.	1·08	2·01	1·53	·88	1·02	·92	1·14	·66	1·11	·87	1·44	1·35	2·09
1849.	1·62	1·58	1·48	1·04	·97	·57	·90	·76	1·52	1·58	1·22	1·52	1·88
1850.	1·13	1·44	1·29	1·41	·92	·89	·58	·74	1·10	1·33	1·67	1·58	1·93
1851.	1·34	1·23	1·79	·79	·93	·94	·71	·60	1·19	1·44	1·05	·99	1·90
1852.	1·32	1·37	1·58	·82	·70	·83	·39	1·49	1·40	1·50	1·43	1·23	1·95
1853.	1·30	1·29	·98	1·15	·63	·59	1·00	1·14	1·23	1·25	·96	1·31	1·77
1854.	1·86	1·11	·91	1·19	1·14	·64	·61	·84	·71	1·59	1·58	1·48	2·05
1855.	1·25	·84	1·60	1·15	·70	1·16	·68	·69	1·06	1·02	·74	1·28	1·73
1856.	1·74	1·01	·90	1·13	·83	·80	·73	1·19	1·50	1·13	1·12	1·65	1·90
1857.	1·40	1·20	1·46	1·39	·97	·88	·72	·61	·95	1·50	1·38	1·01	1·93
1858.	·87	·78	1·51	1·20	1·38	·59	·74	·77	1·09	1·23	1·63	1·08	1·81
1859.	1·56	1·42	1·32	1·31	·57	·68	·68	·70	·95	1·50	1·79	1·94	2·35
1860.	1·65	1·32	1·82	1·45	1·04	1·25	·82	·77	·91	·98	1·18	1·54	1·95
1861.	1·16	1·65	1·32	·90	1·00	·65	1·04	·68	1·04	1·06	1·43	1·28	1·65

TABLE IV.—Barometer at Exeter, 1817–1861, inclusive. (See Plate V.)

Month.	Mean highest.	Probable variation.	Mean lowest.	Probable variation.	Mean range.	Probable variation.	Mean temperature, 1834–1861, of maximum and minimum.	Highest maximum.	Lowest maximum.	Range.	Highest minimum.	Lowest minimum.	Range.	Absolute range.
January	30·589	0·165	29·159	0·284	1·430	0·294	40·0	30·98	30·27	0·71	29·88	28·30	1·58	2·68
February	·543	·181	·217	·332	1·326	·341	41·1	·90	·14	·76	·78	·36	1·42	2·52
March	·534	·138	·223	·314	1·311	·293	43·5	·81	·15	·66	·90	·55	1·35	2·26
April	·422	·142	·288	·224	1·134	·216	48·0	·66	·11	·55	·98	·74	1·24	1·92
May	·395	·115	·445	·176	·950	·198	54·2	·68	·15	·53	·88	28·97	·91	1·71
June	·364	·100	·530	·182	·834	·191	59·7	·55	·09	·46	·93	29·08	·85	1·47
July	·342	·098	·563	·163	·779	·170	62·7	·59	·09	·50	·86	29·17	·59	1·32
August	·353	·079	·467	·232	·886	·228	62·0	·54	·14	·40	·82	28·87	·95	1·67
September	·415	·120	·360	·219	1·056	·237	57·7	·62	·15	·47	·75	·83	·92	1·79
October	·446	·159	·197	·233	1·249	·251	51·8	·74	·07	·67	·87	·74	1·13	2·00
November	·490	·132	·178	·313	1·312	·304	45·4	·73	·21	·52	·72	·25	1·47	2·48
December	30·522	·156	29·152	·319	1·370	·304	42·1	30·77	30·23	0·54	29·75	28·13	1·62	2·64
Year	30·451	...	29·315	...	1·921	0·275	50·7	......	......	...	......	......	...	2·85

ANNUAL GENERAL MEETING.

1862, June 18.

When the business of the Ordinary Meeting had terminated, the Annual General Meeting was held; and the Report of the Council on the state of the Society was read.

REPORT.

The observations at the several stations, scattered over the country, are still made with the utmost regularity, and for the most part with great care. The greater number of monthly sheets, containing the monthly observations, have been received up to the end of May. The examination and reduction of these observations are not in so forward a state as usual, in consequence of the duties of a juror at the International Exhibition having taken up very much of Mr. Glaisher's time; they are now, however, being proceeded with, and the results will be ready for the printer at the usual time.

It has been a matter of much interest to compare the state of meteorological instruments at the present time, and at about the time of the foundation of this Society, almost simultaneous with the Exhibition of 1851.

At that time the French instruments, as exhibited by Fastré, were distinguished for accuracy beyond almost all others, being but little, if any, behind those then exhibited by Messrs. Negretti and Zambra; and but very few other exhibitors had any claim to really good and accurate meteorological instruments.

The International Exhibition of 1862 presents a marked contrast to that of 1851; for whilst Fastré then was pre-eminent, he is equalled this time by several other exhibitors; and his contributions show no advance beyond that of 1851, either in invention, accuracy, or other elements of progress. It is far otherwise in the British department; here advance is shown generally by nearly all the exhibitors. Of new mercurial minimum thermometers there are no less than three:—Casella's, which has been explained to the Society; Negretti and Zambra's furnished with a platina

stop; and Hicks's with a piece of glass soldered to the interior of the bulb and partly projecting into the smaller part of the tube. This instrument seems to be by far the best of the three: it has this great advantage over the two others, that it can be examined at different parts of the scale, as an ordinary thermometer.

Since the Meeting was held, before which this Report was laid, the list has been published of the "Medals and Honourable Mentions awarded by the International Juries," 1862. In further illustration of the remarks that have been made, the lists of Awards made for Meteorological Instruments at the "Great Exhibition of the Works of Industry of All Nations, 1851," and at the "International Exhibition, 1862," are here placed on record in juxtaposition.

The rewards, the names and objects rewarded, with the reasons for the award, are extracted in order and *verbatim* from the respective published lists.

1851. JURY AWARDS.—CLASS X.

COUNCIL MEDAL.

France.—1108. Bourdon, E. The invention of metallic barometers, and for his manometers.

United Kingdom.—144. Brooke, C. The invention of a means of self-registering natural phenomena by photography.

United Kingdom.—145. Dollond, G. Atmospheric recorder, by means of which the reading of the barometer, those of the thermometer, evaporator, fall of rain, direction of the wind, its strength, electric state of the air, &c., are simultaneously registered.

United Kingdom.—331. Griffith, Rev. J. Barometer, with a vacuum capable of complete restoration by an air-trap at the top.

United Kingdom.—674. Newman, J. The originality, excellence and perfection of his ...... and self-registering tide-gauge.

France.—Vidi. The invention of the aneroid barometer.

PRIZE MEDAL.

United States.—146. Ericsson, J. Sea-lead, pyrometer, &c.

France.—501. Fastré, J. T. Thermometers.

France.—1239. GALY, CAZALAT. Manometer, upon the hydraulic principle.

United Kingdom.—152. HEWITSON, J. Tide-gauge.

Denmark.—17. JURGENSEN and SONS. Metallic thermometer.

United Kingdom.—322. LLOYD, Lieut.-Col. J. A. Storm-indicator, a typhodeictor.

United Kingdom.—160 A. NEGRETTI and ZAMBRA. Meteorological instruments on glass.

HONOURABLE MENTION.

Belgium.—183. DEHENNAULT, J. B. Anemometer.

United Kingdom.—411. PHILLIPS, J. Rain-gauge, anemometer.

1862. JURY AWARDS.—CLASS XIII.

MEDAL.

United Kingdom.—BECKLY. For his registering anemometer, and for &c.

United Kingdom.—2874. CASELLA, L. P. For his mercurial minimum thermometer, and accuracy and excellence of construction of thermometers, &c.

United Kingdom.—2911. HICKS, J. For the best mercurial minimum thermometer exhibited.

United Kingdom.—2865. KEW OBSERVATORY. The excellence and accuracy of construction of instruments for observing terrestrial magnetism.

United Kingdom.—2939. NEGRETTI and ZAMBRA. Meteorological instruments. For many important inventions and improvements, together with accuracy and excellence in objects exhibited.

United Kingdom.—2962. SPENCER, BROWNING, and Co. ...... and aneroid barometers. For general excellence and economic production.

France.—1392. FASTRÉ, J. T. For the great accuracy of his thermometers, &c.

HONOURABLE MENTION.

United Kingdom.—2920. Johnson, H. .... and deep-sea thermometer. For novelty of construction.

France.—1410. Dutrou, E. P. For the good workmanship of his meteorological instruments.

France.—1391. Naudet and Co. Aneroid barometers. For successful and economical manufacture.

The following is a summary of the awards made at the respective Exhibitions :—

1851.	Council Medal	6
	Prize Medal	7
	Honourable Mention	2
1862.	Medal	7
	Honourable Mention	3

The respective Reports cannot at present be compared, as the Report of the Juries of the "International Exhibition 1862" is not yet published.

Members have been already informed (Proceed. Meteor. Soc. no. 3. p. 181) of the attempt made on March 22, 1862, to carry out the resolution of the British Association, of making certain observations in the higher regions of the atmosphere, and of its failure in consequence of the defective state of the balloon that had been provided for the observers; and also of the engagement made by Mr. Coxwell to construct a new balloon to be used in the first instance for these observations. This balloon is now completed, and arrangements have been finally closed with respect to the proposed ascents. The balloon is 55 feet in diameter, 69 feet in height from its crown to its mouth, and 85 feet from its crown to the car. It was examined on June 16, and all seemed to be satisfactory. It is proposed that one ascent shall take place from Wolverhampton on Saturday, June 28, at 9 o'clock, and a second on Monday, June 30, if possible.

It is intended to take frequent observations of the dry- and wet-bulb thermometer, both free in air and under the influence of inhalation; also, Regnault's and Daniell's hygrometer will be frequently observed. These instruments, in addition to a barometer by Adie, an aneroid by Negretti, a magnet to note the time of its vibrations, and an electrometer furnished by Prof. Thomson,

will supply quite enough work for our Secretary, Mr. Glaisher, who is charged with these observations. It is intended to devote four or five hours to the ascent, or more if found to be practicable; and it is to be hoped that a fruitful crop of observations will be the results of these experiments, some of which it is expected will be made at the height of five miles from the earth. The calculated cubic contents of the balloon exceed 90,000 cubic feet: it is made of American cloth.

The ascents proposed in June were unfortunately not made. Violent gusts of wind prevailed on the day first proposed, during the course of inflation, and wrested the machine from the hands of those who were holding it down, and so damaged it as to make an ascent at that time impracticable. It was, therefore, postponed until the balloon was repaired, and the weather of this ungenial summer had become more settled. In the meantime, Mr. Proud, the engineer of the gas company, had set himself the task of preparing a very light description of gas, and had collected a large supply of a specific gravity between ·200 and ·300. But the ascent was long delayed, in consequence of the continued variability of the weather; and the unfortunate accident which had happened to the balloon induced greater caution in the selection of the day for the ascent. At length a calmer day was obtained on the 17th of July, and the work of inflating the balloon was commenced at an early hour; and at 9 A.M. 60,000 feet of gas had been turned into the balloon. It left the earth at 9.43 A.M., with the barometer reading 29·50 inches, and the temperature 55°. At 9.47 a temperature was obtained of 45°. At this time the air was dry; and the temperature decreased to 26° by 9.56, the barometer reading 21 inches; the temperature 26° was constant till 10.3, when the barometer reading was 19 inches, and at this time the sun was shining on the balloon with great brilliancy. The strains of a band of music were heard. A peep was obtained at the earth; the fields looked like a tessellated pavement, and the roadways were sharply and clearly defined. Gazing through the thin attenuated air at this altitude did not present the difficulties, which were offered by the thicker stratum below. In five minutes the temperature had increased to 31°, and at a quarter past ten it was 37°. On starting, Mr. Coxwell's pulse was beating at 75, and Mr. Glaisher's at 76; but now the former had risen to 86, and the latter to nearly 100. The gas, which had been opake, became perfectly transparent; and Mr. Glaisher could see through the gas to the top of the balloon, around which the netting clung tightly. Here also

a striking change was observed in the surrounding scenery. From the pale light-blue colour of the sky below, that which now surrounded them was an intensely deep Prussian blue. The cumuli clouds far below were hillocky and rocky in appearance, and the sun was shining upon their surface. The temperature still continued slowly to increase, and was 38° at 10.30; and the barometer reading was less than 15 inches, showing that the aëronauts were nearly four miles high. The palpitations of the heart were audible, so that each could hear the beating in the breast of the other. The ticking of the watch was loud, like a chronometer upon a sounding-board; and the turning of the leaves of the note-book sounded like the rushing of a high wind. At 10.35 the temperature had increased to 42°, at a height of four miles; the air was very dry; the hands of the voyagers were dark blue, and the lips also blue, but not the face. Now the temperature began to decrease with wonderful rapidity. In four minutes it was reduced to 36°; and by 10.47 it was down to 31°. At 11.1 the highest elevation was reached—the barometer reading a little above 11 inches; and it was evident that the voyagers had ascended to very nearly five miles. Here the temperature was 16°; and the breathing, which was interfered with when heart-palpitation commenced, again became affected. A deep-blue sky was to be seen at this point, with clouds below; and the cold was felt. At 10.57 the feeling of sea-sickness, with its uncomfortable manifestations, came over Mr. Glaisher; and at 11.7 the same feeling returned, but it was not so prolonged in duration. It has been stated that at this height blood issues from the nose, that the eyes are affected, and a tingling in the ears is experienced; but none of these manifestations were perceived. Mr. Coxwell only found it necessary to throw on one additional coat whilst they were up; and Mr. Glaisher, after wrapping a cloak around him for a short while, soon threw it off. The fingers were not benumbed, nor were either of the voyagers uncomfortably cold. When they were between three and four miles high, it was suggested that the balloon should make its first "dip," it being desirable, in order to the perfecting of the experiments, to descend to the earth two or three times before making the final ascent to the highest altitude; but, being too near to the Wash, the attempt was abandoned, and the ascent to the highest elevation was made at once.

During the last mile there was the extraordinary fall of 27° in the temperature. On the earth, as we have said, it was 55°; at half a mile it was 45°; at less than a mile it was 43°; it then

decreased to 26°. At about two miles it increased constantly till the height of four miles was reached, when it was 43°; and between four and five miles it rapidly decreased from 43° to 16°. The air was dry throughout. At the highest elevation the dry-bulb thermometer read 16°, and the wet-bulb 9°. Regnault's hygrometer at zero had no dew, nor had Daniell's hygrometer any dew at 8° below zero. No dew could be deposited at this elevation on either of the hygrometers. At 11.42, when they were above the clouds, the earth was visible and the Wash in the distance. The voyagers then brought the balloon down as quickly as possible, the shadow of the balloon on the clouds continuing to increase as the clouds were neared. In passing through the clouds, the balloon could not be seen from the car, in consequence of the density of the clouds.

The descent was effected at Langham, near Oakham, in a meadow near the residence of Mr. E. G. Baker. So rapidly were they coming down that Mr. Baker, fearing an accident, prepared restoratives. Mr. Glaisher, however, only sustained slight injuries to the face and hand, from which he suffered little inconvenience on the following day. The rapidity of the descent was owing in great part to the excessive cold from which the voyagers descended. Mr. Baker showed the utmost attention to the voyagers, and did not leave them till after he had entertained them at his own table and had taken them to the railway in his own carriage; and they reached Wolverhampton about midnight.

During the flight, the ozone-papers remained uncoloured. The time of vibration of a horizontal magnet seemed to be somewhat lengthened with increase of elevation. This result is contrary to that found by Gay Lussac in 1804 (see 'Annales de Chimie' for January 1805, page 73): he then found that twenty vibrations of a magnet were made in 84 seconds, whilst on the earth twenty vibrations occupied 84^s·33.

The instruments were considerably damaged in the landing, but they can all be repaired. The balloon was all that could be expected, and Mr. Coxwell feels sure he can get up six miles with it.

Mr. Coxwell having arranged an ascent with this balloon from the Crystal Palace, for July 30, Mr. Glaisher availed himself of the offer of a seat in the car for the purpose of taking similar observations at moderate elevations.

The instruments used were made by Messrs. Negretti and

Zambra, to replace those broken in the ascent from Wolverhampton. They consisted of two aneroid barometers, one graduated to 13 inches, and the other to 5 inches, and both had been placed in an exhausted receiver simultaneously with a mercurial barometer; a pair of very delicate dry- and wet-bulb thermometers, of extreme sensitiveness, so that they readily acquire the temperature of the surrounding air.

The air was in very gentle motion, which enabled Messrs. Negretti and Zambra carefully to fix the instruments before starting, so that Mr. Glaisher at once began to observe, which in his former ascent he was unable to do until the greater part of a mile high.

The balloon left the earth at $4^h\,40^m\,10^s$, conveying thirteen gentlemen, with a large amount of sand for ballast, and, under the influence of a moderate breeze, bore away slowly nearly S.E., passing successively Eltham and Dartford, to the village of Singlewell, near Gravesend.

The approximate heights of the balloon successively were as follows:—at 4.43 it had attained the elevation of 1340 feet above the level of the sea; at 4.49 that of 3700 feet, increasing slowly; at 5.17 it was about 5300 feet. It then, by 5.20, fell 200 feet. On throwing out sand it rose to 5500 feet by 5.24, and to 6600 feet by 5.43. Some gas was let out, and it sank to 5700 feet by 5.47. Some sand was then thrown out, and it rose to 7350 feet—the highest point reached—at 6.1. At 6.6 it fell to 6700 feet. Some sand was thrown out, and it rose to 7100 feet by 6.12. At 6.20 it descended to 5300 feet, and slowly to 2100 feet at 6.25, and to the earth a little after 6.30.

Between 4.46 and 5.1 the altitude and azimuth of the balloon were observed at the Royal Observatory, Greenwich, by E. J. Stone, Esq., M.A.

The temperature of the air was 68° at the Crystal Palace. At 4.40½, at the height of 100 feet, it was 67°; at 4.41¼, at the height of 300 feet, it was 66°, decreasing gradually. It was noted at first every 15 seconds; and afterwards, for the most part, at every ½ minute, till 6.25. At 1000 feet high it was 62°; at 3700 feet it was 51°; it continued at this reading nearly till the height of 4500 feet was reached. At 5.4 it varied between 48° and 50° till the height of 5700 feet; it decreased from 48° to 43½° between 5.31 and 5.38, the height at the latter time being 6100 feet. At the height of 7350 feet the temperature was 41°, being 27° lower than on the surface of the earth. After this the temperature rose gradually as

the balloon descended, and was 47° at 6.20, 50° at 6.24, and 68° on reaching the ground.

The temperatures of the dew-point were successively as follows: —in the gardens of the Crystal Palace it was 50°; at the height of 1300 feet 43°; between 3000 and 4500 feet about 40°; then up to 6000 feet, at temperatures gradually decreasing to 36° at 5310 feet; at about 7300 feet, a little below 32°; and it afterwards increased to 47° on reaching the surface of the earth. On the earth the temperature of the dew-point was 18° below that of the air; and at the highest elevation it was 9° below. The amount of water in the grounds of the Crystal Palace was 4 grains in a cubic foot of air; at 1300 feet high, 3 grains; at 5000 feet, only 2½ grains; and at 7300 feet, 2 grains.

The humidity of the air on the surface of the ground was 50, showing an unusual degree of dryness. It increased to 60 at 3000 feet, to 66 at 4000 feet, and to 70 at 7300 feet; and the air gradually became less humid on approaching the earth. At no point was complete saturation met with. The weight of a cubic foot of air varied from 526 grains on the ground to 429 grains at the greatest height reached.

Observations of the wet-bulb thermometer were made simultaneously with those of the dry-; and observations of the dew-point temperature, as determined by means of Daniell's hygrometer, were made frequently.

Similar and simultaneous observations were taken at the Royal Observatory, Greenwich, which show that the temperature of the air on the surface of the ground varied from 67° to 68°; that of the dew-point, from 49° to 51°; that there were about 4 grains of water in a cubic foot of air; that the degree of humidity was about 50; and the weight of a cubic foot of air was 526 grains; these values being almost identical with those determined at the Crystal Palace, and at Singlewell on reaching the ground.

As at Wolverhampton, test ozone-papers were not coloured at all. A horizontal magnet occupied a somewhat longer time to perform a certain number of vibrations.

The full details of the results of the observations cannot be given till after a great deal of labour has been devoted to their reductions. The results will be first communicated to the meeting of the British Association at Cambridge.

At 5.24 a gun was heard, with a sharp sound; at 5.25 a drum was heard; at 5.26 a band was heard; at 5.38 a gun was heard; and at 6.10 a dog barking was heard, and the working of the

engines on the Dover and Chatham Railway was distinctly heard.

W. F. Ingelow, Esq., kindly read one barometer, and rendered considerable assistance in noticing the first appearance of dew on the black bulb of Daniell's hygrometer.

Mr. Glaisher feels indebted to the Directors of the Crystal Palace, and to George Grove, Esq., for every assistance he needed. The latter gentleman was one of the thirteen who occupied seats in the car on this occasion.

The descent took place at a quarter to seven, in a field at Singlewell, near Gravesend, and was very steady and gentle.

Mr. Glaisher made the *Second* ascent from Wolverhampton at $1^h\ 2^m\ 38^s$, on Monday, August 18; and descended at 4.5 at Solihull, twenty-five miles distant, and seven miles from Birmingham. The greatest height attained was four and a half miles, when the temperature was 24°; the barometer 13 inches; the dew-point −10°. Here the hands became of a blue hue, and a qualmish sensation affected the brain and stomach, resembling the approach of sea-sickness. Upon Mr. Glaisher these sensations proved of a severe character, and the headache was intense. The pain in the head and the sickness increased later in the day, and they seemed to reach their most distressing point between ten and eleven o'clock at night; and he had by no means recovered on the following day.

The former observations relative to the dryness of the atmosphere in the higher regions were confirmed on Monday; but at the lower elevations the observations taken tend to favour previously conceived opinions. On the first ascent no ice was noted upon the wet- and dry-bulbs of the thermometers; but on this occasion they both were covered with a compact cake of ice. No ozone was detected on the former occasion; but on Monday there was as much, we think, as 9 points. The dew-point on starting was 51°, or 17° decrease upon the air (68°). At about half-past two o'clock, when the height was four miles, and the temperature 28°, the dew-point was 6°; in five minutes afterwards it was 3°; and it afterwards varied from minus 5° to minus 10° at the highest altitude at 3.20 o'clock. On descending to the earth it gradually increased to 50°.

Throughout the entire three-and-a-half hours on Monday, a magnificent white cloud followed the balloon in all its wanderings. Immediately the voyagers had left the lower region, and had ascended, it seemed to come forth and act as their body-guard, till

having seen them once again safe into the lower strata, it bade them a gracious farewell.

At all points of observation the horizon was seen at a line horizontal with the point of observation, namely, from the car; so that if aim had been desired to be taken at the horizon with a rifle, the weapon might have been rested upon the edge of the car without elevation or depression, as the sportsman knelt within it. The descent was determined upon at about half-past three.

On August 20, at 6.26 P.M., Mr. Glaisher made a *Second* ascent from the Crystal Palace Gardens. The following are some general data of the trip:—

P.M.	Thermometer. °	Wet-bulb. °	Height. mile.
6.26	66	68·25	
6.35	54	......	·5
6.37	...	......	·75
6.43	50	48	1·0
7.9	48	......	1·0
7.19	...	......	·3
7.40	57	54	·5
7.42	51	......	·6
7.47	45	......	1·0
	43		
8.5	55		

The evening was particularly calm. They hovered over the gardens for some time, and after floating an hour were only a mile or two distant, and continued hovering over London until it was too dark to make observations. The descent was made about a mile and a half from Hendon; and the balloon was anchored for the night.

On August 21, at 4.30 A.M., a re-ascent was made from Hendon. The greatest height, a little over three miles, was attained at 5.34 A.M. The temperature was 19°, the wet-bulb 5° or 6° lower; and the temperature then increased as the sun rose. At 4.57 while in the cloud, surrounded on every side by white mist, the temperatures of the air and dew-point were alike, as both the dry- and wet-bulb read 39¾°. The light rapidly increased; and on gradually emerging from the dense cloud the voyagers found themselves in a basin surrounded with immense mountains of cloud rising far above, and shortly afterwards looking into deep ravines, bounded with beautiful curved lines. The sky immediately overhead was blue, dotted with cirrus clouds. Continuing to ascend,

the tops of the mountain-like clouds became silvery and golden. At 5.1, when level with them, the sun made its appearance, flooding with golden light all the space visible for many degrees both right and left, tinting it with orange and silver. It was a glorious sight indeed. At this time they were about 8000 feet high, and the temperature had increased from 38½° in the cloud to 41°. The descent took place a little after 7 A.M. at Danton Lodge, near Biggleswade, on the estate of Earl Brownlow.

On September 1, Mr. Glaisher made a *Third* ascent from the Crystal Palace.

On September 5, he made his *Third* ascent from Wolverhampton at 1 P.M., descending at 3.20 P.M., seven and a half miles from Ludlow in Shropshire. The extreme height attained was estimated to be *six* miles; the lowest temperature was probably below —10°. Pigeons sent from the car fell like a stone, powerless to fly. Mr. Glaisher became unconscious; Mr. Coxwell felt faint, and his hands were powerless. Had he not succeeded in pulling the valve-cord with his teeth, their safety would have been compromised. A barometer, specially constructed by Negretti & Co., for dispensing with corrections for capacity of cistern, was taken in this trip.

Mr. Glaisher made a *Fourth* (being, in all, his Eighth) ascent from the Crystal Palace on September 8.

Mr. Glaisher hopes to communicate to the Society at the next Meeting some of the results collected in these voyages.

Reverting from these matters, which refer rather to meteorology generally, and to certain points of progress in the science, your Council have to call your attention more especially to the present condition and the probable future of this Society, pointing out some of the features by which the Session now terminated has been peculiarly characterized.

The Council had long ago seen the urgent necessity, as well as the extreme propriety, of putting the Members of the Society more promptly in possession of the papers that are read at the ordinary Meetings; and their very serious attention was directed to this question. They forebore to commence rashly the publication of any form of Journal; they hesitated until they felt some degree of assurance that the means at their command would enable them to continue what they might propose to commence.

It was at length resolved, at the Council Meeting held on October 16, 1861, that the papers read at each Ordinary Meeting of the Society should be published in a Journal, which should be issued

as early as might be conveniently practicable after each Meeting. The "Monthly Notices of the Royal Astronomical Society" were accepted as a guide to the general form which the Journal should assume; and it was arranged that the title should be 'Proceedings of the British Meteorological Society.' A "Publishing Committee" was formed; and one of the Secretaries volunteered to take general charge of the 'Proceedings,' as far as editorial work was concerned, at least until the publication was established on a permanent basis, and the Society was stronger.

It is proper also that Members should know that the first Number of the 'Proceedings' (which is a thick number) was produced at very little expense to the Society itself. Three Members kindly placed in the Treasurer's hands sums of money nearly sufficient to defray all printing charges. The figures will be found in their proper places in the Treasurer's Report.

The general character of the 'Proceedings' is now familiar to Members, three Numbers having been issued. The result of this measure is in accordance with the reasonable expectations which the Council entertained when they resolved upon publication at short intervals. Country Members especially, many of whom are unable to be present at the Ordinary Meetings, have fully recognized the value of the 'Proceedings.' It establishes a closer link between them and the Society. They are soon put in possession of the papers that are read; and their attention is directed to other publications connected with the science, that in many cases are hardly otherwise accessible to many among them; and thus the Society is more useful.

The unusually large accession of new Members during this Session is in no small measure to be attributed to the publication of the 'Proceedings.' At the one Meeting, for instance, on March 19, as many as thirty-four Members were elected; and at the Ordinary Meeting which has just been held thirty-two have been added, and also two Honorary Members, Professors Dove and Regnault. The total number of ordinary Members elected during the Session that is now ended, has been seventy-two; and among them are not a few who hold a high rank in science, and whom we are glad to welcome among us.

Meteorological science has greatly attracted public attention during the last few years; and your Council have every reason to anticipate that this Society will increase in strength and usefulness, and that the day may not be far distant when they shall feel justified in taking the sense of Members as to the propriety of seeking for a Royal Charter of Incorporation.

There were certain resolutions passed at the last Anniversary Meeting which have greatly facilitated the election of Members. The abolition of the entrance-fee has doubtless had some influence over a few of the candidates; but the change which has been of great practical importance has been the recognition of Council Meetings for all steps towards elections, except for the actual election itself. Holding, as the Society does, but *four* Ordinary Meetings in the year, the time between the nomination and election of a Member used to extend over several months, which naturally made admission into the Society a very slow and tedious process. The modification introduced into the Institutes has worked most satisfactorily; and the Council are gratified to say that the applications for admission from eligible candidates have been so continuous during the present Session, that Special Meetings of the Council have been more than once called in order that no unnecessary delays should occur in promoting the election of new Members.

These active signs of vitality, even if they stood alone, are an eloquent acknowledgment on the part of the Society that the Members generally approve of the progress that has been attempted. They have evidently called the attention of their friends to the Society, and have satisfied them of its increased and increasing usefulness, and have thus led them to become candidates for admission. The Council trust that these exertions will not cease. The population of this country has essentially a meteorological tendency, and there are hundreds of men, more or less acquainted with the science—there are thousands more or less interested in the study of the weather—who are highly worthy of being enrolled among us, and who will, from time to time, find their way to us, as they become informed of our constitution and of the way of access to us. It only requires a little industry and a little energy on the part of individual Members, each in his own circle, in his own district, largely and effectively to add to our ranks, not merely men who will, as Members, contribute to the Treasurer's chest, but men who will contribute to the pages of the 'Proceedings' and to the advance of the science. From the experience of the past session, and from a knowledge of the wide interest taken in meteorology, it is not too much to expect that the present number will soon become doubled and redoubled.

Members must look forward to the time when we shall have greater vigour, and yet be self-sustaining. At present, the rooms in which we meet are kindly placed at our disposal by the Council of the Institution of Civil Engineers, and greatly are the Society

indebted to that Institution for the uniform courtesy that has been manifested toward us since we have met under this roof.

Of course the Council cannot fail to look forward to the time when we shall have offices of our own, where Members will find the books and MSS. of the Society, and an officer of the Society in charge, so that facilities may be offered to Members which are, to a certain extent, impracticable at present.

Heretofore the Council have retained but a small amount of paid assistance; the conduct of its affairs is in the hands of gentlemen whose days are fully occupied in their several avocations, official or otherwise. They have heretofore been able agreeably to devote a sufficient portion of their leisure hours to the business of the Society, and will, doubtless, be able so to continue; but if otherwise, volunteers will not be wanting—they never have been—to take charge in any emergency that may arise.

As a Society, we have been able to show no special marks of attention to the many illustrious philosophers who are now visiting this country. We have had no Ordinary Meeting since they have been here until that of this evening. The President, however, has not allowed the occasion to pass. He received the Council and others at his table to meet some foreign meteorologists, whose names have more than a European reputation. And the Society have this evening conferred the rank of Honorary Members upon Professor Dove of Berlin and Professor Regnault of Paris, in recognition of their eminent rank as meteorologists, and of the services they have conferred upon the science.

At this time last year, the books belonging to the Society were in a back attic at No. 24 Great George Street, Westminster, whither they had been removed on the death of Mr. R. Stephenson, who had allotted them a space in his library: they were quite inaccessible to Members for consultation, as they were sealed up in brown-paper wrappers to preserve them from dust. On the President, Mr. Beardmore, being made acquainted with the unsatisfactory condition of the Library, he most liberally offered accommodation in his offices at 30 Great George Street; and the books were removed there at the end of June 1861. Mr. Beardmore further presented the Society with a book-case capable of containing two-thirds of the whole number of books. The remainder are laid by in deal boxes.

Of the books collectively, somewhat more than half are bound, and of these nearly a quarter at the private expense of the President; the remainder consist in a great measure of pamphlets,

many of them very valuable. The Society might advantageously spend a few pounds in binding these together.

There are many books belonging to this Society which have no relation whatever to meteorological science; it remains with the Council to determine their destination: at present these books occupy much of the limited space at our disposal.

The Society has also in its possession a considerable number of duplicate volumes.

A printed Catalogue of the books in the Library will be in the hands of Members, with the present Number of the 'Proceedings.'

The majority of works now forwarded to the Society is from foreign sources. Among the contributors are Professor Quetelet of Brussels, Professor Kämtz of Dorpat, the Smithsonian Institution, Washington, the Hydraulic Commission of Lyons, the Academy of Sciences at Madrid, and the Observatories in Australia: from home sources, we get, through Admiral FitzRoy, the meteorological papers published by the authority of the Board of Trade; the Royal Engineers' Observations, from Sir H. James; and a comprehensive Quarterly Report from the Scottish Meteorological Society. This continual encroachment on our room will, ere long, necessitate the removal of the Library to more extensive quarters.

The List of Members has been revised, and a new edition, corrected to the present date, has been prepared; it is forwarded to Members with this, No. 4 of the 'Proceedings.' From this list it will be seen that the Society, at the present time, consists of—

Life Members	27
Ordinary Members	203
Honorary Members	11
Total	241

The names of several Candidates for admission have been received since the Annual Meeting.

The financial condition of the Society will be gathered from the Treasurer's Report which follows. It commences with the balance remaining in hand in December 1859, shown in the Report for the Session ending June 1860, and extends to June 1862. All bills have been paid. The Council are not aware of any outstanding accounts; and there is a certain amount yet to be received for subscriptions due.

Account of the Treasurer of the British Meteorological Society for the year 1860.

Receipts.

Date		£	s.	d.	£	s.	d.
1860.							
Jan. 1.	To Balance				39	13	6
Apr. 18.	Life Composition, Dr. Reynolds	12	0	0			
Apr. 19.	Do. J. Hippisley, Esq.	12	0	0			
	Do. H. Barrow, Esq.	12	0	0			
June 28	Do. W. H. Ellis, Esq.	12	0	0			
June 30.	Subscriptions, by Treasurer	83	1	0			
	Do. Collector	81	2	0			
June 30.	To total *Receipts*				212	3	0
					£251	16	6
1860.							
July 1.	To Balance				99	2	9
Aug. 1.	Life Composition, S. W. Silver, Esq.	12	0	0			
Oct. 17.	Do. T. Wickstead, Esq.	12	0	0			
Nov. 12.	Do. D. Knapping, Esq.	12	0	0			
Oct. 17.	Donation, J. Burn, jun., Esq.	1	0	0			
Dec. 31.	Subscriptions, by Treasurer	18	0	0			
	Do. Collector	4	0	0			
Dec. 31.	To total *Receipts*				59	0	0
					£158	2	9
1861.							
Jan. 1.	To Balance				£105	9	6

Expenditure.

Date		£	s.	d.	£	s.	d.
1860.							
Apr. 17.	Paid for Postage Stamps				4	0	0
	Do. Assistant Secretary;—Jan., February, March				13	0	0
	Do. for Printing Report of 1858				92	13	6
June 30.	Do. Meteorology of Scotland, June 1856 to December 1857				18	6	0
	Do. Assistant Secretary;—April, May, June				13	0	0
	Do. for Stationery	0	19	6			
	Do. Postage Stamps	2	1	3			
	Do. Printing	4	12	6			
					7	13	3
	Do. Collector's per-centage				4	1	0
	By *Disbursements*				£152	13	9
	Balance at Banker's	88	6	0			
	Do. Treasurer's	10	16	9			
					99	2	9
					£251	16	6
1860.							
Sept. 30.	Paid Assistant Secretary;—July, August, September				13	0	0
Oct. 17.	Do. Postage Stamps	1	0	0			
Dec. 31.	Do. do.	4	0	0			
	Do. Printing Cards of Meetings	1	2	6			
					6	2	6
	Do. Collector's per-centage				0	4	0
	Do. Attendance, Refreshments at Meetings, &c.				7	6	9
	Do. Assistant Secretary;—October, November, Dec.				13	0	0
	Do. Printing Address:—On Practical Importance of Meteorology, by President, T. Sopwith, Esq.				6	6	6
	Do. for Registrar-General's Quarterly Reports;—December 1859, March, June, September 1860				6	13	6
	By *Disbursements*				£52	13	3
	Balance at Banker's	97	6	0			
	Do. Treasurer's	8	3	6			
					105	9	6
					£158	2	9

HENRY PERIGAL, Jun., *Treasurer.*

Account of the Treasurer of the British Meteorological Society for the year 1861.

Receipts.

		£	s.	d.	£	s.	d.
1861.							
Jan. 1.	To Balance				105	9	6
Apr. 9.	Dividend on £370 New 3 per C., Apr. 1860	5	8	9			
	Do. do. Oct. 1860	5	6	5			
	Do. do. Apr. 1861	5	6	5			
		16	1	7			
June 30.	Subscriptions, by Banker	1	0	0			
	Do. Treasurer	19	3	0			
	Do. Collector	24	0	0			
Jan. 23.	Life Subscription and Admission:						
	H. Johnson, Esq.	13	0	0			
June 30.	To total *Receipts*				£73	4	7
					£178	14	1
1861.							
July 1.	To Balance				73	7	7
Oct. 16.	Dividend on £400 New 3 per Cents ...	5	15	6			
Dec. 31.	Subscriptions, by Treasurer	2	0	0			
	Do. Collector	9	0	0			
Oct. 5.	Life Subscription and Admission:						
	Lieut. W. Chimmo, R.N.	13	0	0			
Dec. 31.	To total *Receipts*				£29	15	6
	Contributions towards printing 'Proceedings,' No. 1:						
Nov. 26.	Do. by S. W. Silver, Esq. ...	10	0	0			
Dec. 31.	Do. do. ...	5	0	0	25	0	0
	Do. by N. Beardmore, Esq. ...	10	0	0			
					£128	3	1
1862.							
Jan. 1.	To Balance				£34	13	11

Expenditure.

		£	s.	d.	£	s.	d.
1861.							
Apr. 5.	Paid for Postage Stamps				2	0	4
Mar. 31.	Do. Assistant Secretary;—January, February, March				13	0	0
June 30.	Do. do. ;—April, May, June				13	0	0
	Do. Postage Stamps	2	0	2			
	Do. Stationery	0	16	0	3	12	8
	Do. Printing Balloting Lists	0	16	6			
	Do. Do. Reports for 1859 and 1860				47	1	0
	By *Disbursements*				78	14	0
27.	Investment of Life Subscriptions, £30 New 3 per Cents, at 88¾				26	12	6
30.	Balance at Banker's	70	8	7	73	7	7
	Do. Treasurer's	2	19	0			
					£178	14	1
1861.							
July 9.	Paid for 300 Cards of Meetings				1	4	6
Aug. 27.	Do. Stationery				0	13	0
	Do. Postage Stamps				3	0	4
Sept. 30.	Do. Assistant Secretary;—July, August, September				13	0	0
Nov. 23.	Do. Postage Stamps				3	0	4
Dec. 31.	Do. Attendance;—Refreshments at Meetings, &c.				7	7	4
	Do. Collector's per-centage				2	5	0
	Do. Assistant Secretary;—October, November, Dec.				13	0	0
	Do. Registrar-General's Quarterly Reports, Dec. 1860, March, June, September 1861				9	16	6
	Do. Printing 'Proceedings,' No. 1	43	4	2	40	2	2
	Less, for Advertisements	3	2	0			
	By *Disbursements*				93	9	2
	Balance at Banker's	11	12	11	34	13	11
	Do. Treasurer's	23	1	0			
					£128	3	1

HENRY PERIGAL, Jun., *Treasurer.*

Account of the Treasurer of the British Meteorological Society for the year 1862.

Receipts.

1862.		£ s. d.	£ s. d.	£ s. d.
Jan. 1.	To Balance			34 13 11
June 30.	Sale of Reports		5 1 7	
	Do. Proceedings		6 5 7	
			11 7 2	
	Subscriptions, by Banker	1 0 0		
	Do. Treasurer	61 3 0		
	Do. Collector	39 2 0		
			101 5 0	
June 21.	Life Subscriptions, W. W. Saunders, Esq.			
23.	Do. B. Botfield, Esq., M.P.		30 0 0	
25.	Do. H. F. Barclay, Esq.			
Feb. 17.	Towards printing 'Proceedings' No. 1,— J. C. Bloxam, Esq.		2 0 0	
June 30.	To total *Receipts*			144 12 2
				£179 6 1
1862. July 1.	To Balance			£48 1 11

Expenditure.

1862.		£ s. d.	£ s. d.
Mar. 31.	Paid Assistant Secretary;—Jan., February, March		13 0 0
	Do. for Postage Stamps	1 0 0	
	Do. do. do. and Stationery	7 13 2	
	Do. Printing Balloting Lists, &c.	0 18 6	
			9 11 8
June 30.	Do. Assistant Secretary;—April, May, June		13 0 0
	Do. Collector's per-centage		1 19 0
	Do. Postages of Secretary (C. V. W.)	0 12 6	
	Do. do. Librarian	0 5 0	
			0 17 6
	Do. Waterlow, Stationery		1 10 6
	Do. Registrar-General's Quarterly Reports, Dec. 1861, March and June 1862		5 1 0
	Do. Printing Notice to Advertisers, Prospectus, &c.		2 13 6
	Do. do. Proceedings, No. 2	22 11 0	
	Less, for Advertisements	3 12 0	
			18 19 0
	Do. do. Proceedings, No. 3	21 16 0	
	Less, for Advertisements	3 16 6	
			17 19 6
	By *Disbursements*		84 11 8
	Investment of Life Compositions, £50 New 3 per Cents, at 93¼		46 12 6
	Balance at Banker's	37 15 11	
	Do. Treasurer's	10 6 0	
			48 1 11
			£179 6 1

HENRY PERIGAL, Jun., *Treasurer*.

The Report of the Council was received and adopted.

A ballot was then taken, and the following list, prepared and proposed by the retiring Council, was received and adopted as Council and Officers for the Session 1862–63.

THE OFFICERS AND COUNCIL

OF

THE BRITISH METEOROLOGICAL SOCIETY,

ELECTED 18TH OF JUNE, 1862.

President.

N. BEARDMORE, ESQ., C.E., F.R.A.S., F.R.G.S., F.G.S. &c.

Vice-Presidents.

C. BROOKE, ESQ., M.A., M.B., F.R.S.
J. LEE, ESQ., LL.D., F.R.S., F.R.A.S., F.G.S., F.L.S., F.S.A.
T. SOPWITH, ESQ., M.A., F.R.S., F.G.S.
R. D. THOMSON, ESQ., M.D., F.R.S. L. & E.

Treasurer.

HENRY PERIGAL, ESQ., F.R.A.S., 57 *Warren Street, Fitzroy Square*, W.

Secretaries.

J. GLAISHER, ESQ., F.R.S., F.R.A.S., *Dartmouth Place, Blackheath*, S.E.
C. V. WALKER, ESQ., F.R.S., F.R.A.S., *Fernside, Red Hill, Reigate.*

Librarian.

H. S. EATON, ESQ., M.A., 30 *Great George Street*, S.W.

Council.

REV. H. BEATTIE, M.A.
ANTONIO BRADY, ESQ., M.M.S.
W. C. BURDER, ESQ.
REV. S. CLARK, M.A.
W. P. DYMOND, ESQ.
F. GALTON, ESQ., M.A., F.R.S., F.G.S., Hon. Sec. R.G.S.
J. P. HARRISON, ESQ., M.A.
H. JOHNSON, ESQ.
S. W. SILVER, ESQ.
D. SLATE, ESQ.
J. W. TRIPE, ESQ., M.D.
S. C. WHITBREAD, ESQ., F.R.S., F.R.A.S.

It was then proposed by T. Sopwith, Esq., M.A., F.R.S., and seconded by C. Brooke, Esq., M.A., F.R.S.:—

> That the cordial thanks of the British Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted the Society free permission to hold their Meetings in the Rooms of the Institution during the Session that has just ended:

which was carried unanimously.

The following Resolution was proposed by G. J. Symons, Esq., and seconded by T. W. Burr, Esq., F.R.A.S.:—

> That the thanks of the Society be given to the Officers for their services during the Session that has now closed:

which was carried unanimously.

NOTICE.

Session 1862-63.

The Meetings will be held on Wednesdays, at

25 Great George Street, Westminster, S.W.,

by the kind permission of

The Institution of Civil Engineers.

Ordinary Meetings at 7 P.M.

1862.	November	19	1863.	March	18
1863.	January	21	„	June	17

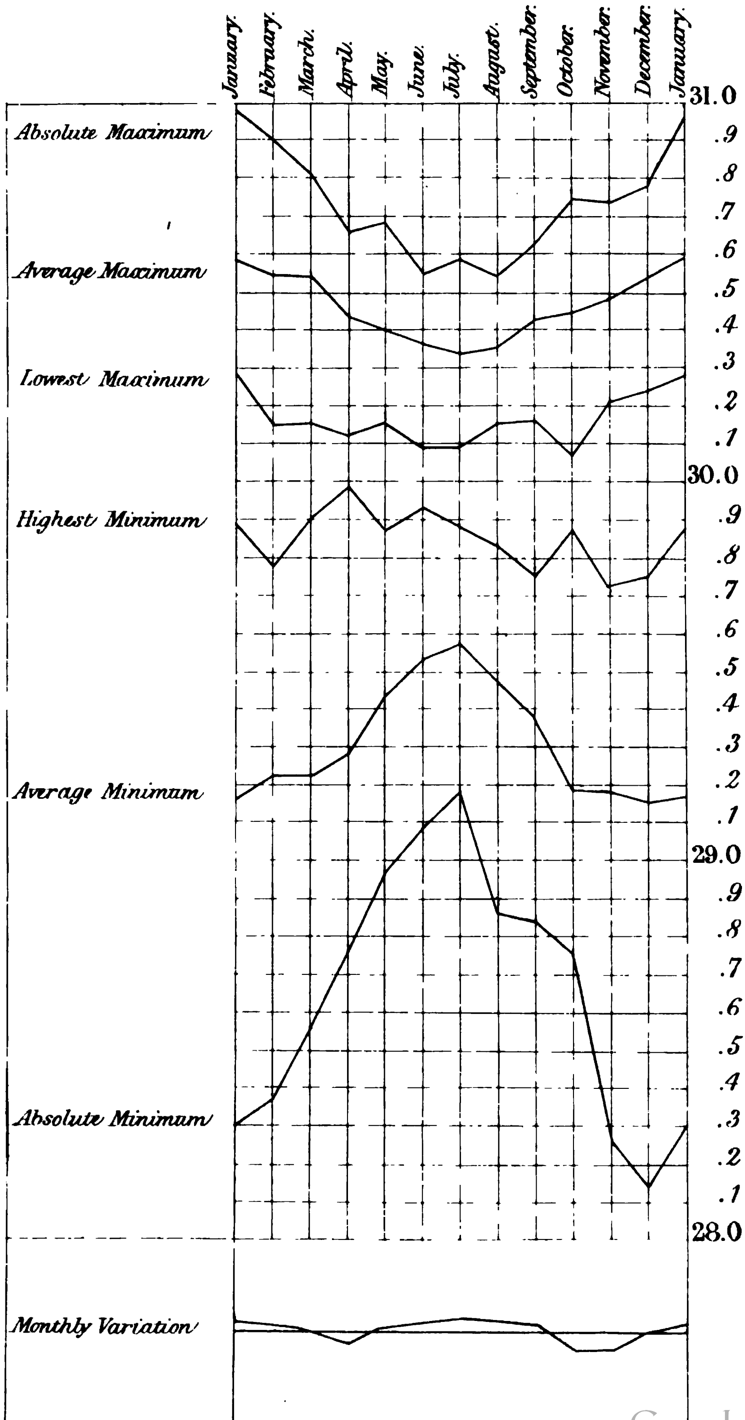
The Annual General Meeting will be held at the close of the Ordinary Meeting on June 17.

Meetings of Council.

1862.	October	15	1863.	March	18
„	November	19	„	April	15
1863.	January	21	„	June	17
„	February	18			

PLATE V.

Barometer at Exeter, 1817- 1861.



Scale, 2 inches to 1 inch

Basire, lith.

[*Price Two Shillings and Sixpence.*]

Vol. I.] [No. 5.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

1862, NOVEMBER 19.

CONTENTS.

LONDON:

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

Published 1863, *April* 7.

PRINTED BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

NOTICE TO MEMBERS.

No. 6 of the 'Proceedings' is in type and will be forwarded to Members in a few days. It contains the papers read on January 21, and other matter.

The four Numbers of the 'Proceedings,' published for the last Session, are to be obtained from Messrs. Taylor and Francis for Nine Shilings.

Members are requested to forward Notes and Notices for insertion in the 'Proceedings' to one of the Secretaries.

[*Advertisements continued on the fourth page.*

BRITISH METEOROLOGICAL SOCIETY.

This Society was established in the year 1850, for the encouragement and promotion of Meteorological Science.

It consists of Members and Honorary Members.

Every person desirous of admission into the Society must be recommended by at least Three Members, of whom one must certify to his personal knowledge of such Candidate.

Candidates may be proposed at a Council Meeting; but the ballot must take place at an Ordinary Meeting. One Council or Ordinary Meeting must intervene between the nomination and the day of Election.

There is no Admission Fee. The Annual Contribution is £1; due on January 1. The Composition Fee is £10.

Persons eminent in Meteorological Science, not permanently residing in this country, are eligible as Honorary Members.

The Council of the Institution of Civil Engineers allow the Society to hold their Meetings at the Institution, No. 25 Great George Street, Westminster, S.W.; and to receive letters there.

Four Ordinary Meetings are held during the Session, which commences in October and terminates in June, at which Members can introduce their friends.

Papers accepted for reading at the Ordinary Meetings are published entire or in Abstract in the 'Proceedings' of the Society, which are issued as soon as possible after each Meeting, *and of which a copy is sent to every Member of the Society*. The 'Proceedings' also contain Notices of Books and Memoirs, descriptions of New Instruments, and other Meteorological News.

Daily observations are made, for the most part by Members of the Society, at about 60 different stations, which are forwarded monthly to one of the Secretaries, by whom each reading is examined and collated with readings made in adjacent stations. Their means are taken; and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of each 'Quarterly Meteorological Report' *is sent free to every Member of the Society*.

Copies of printed results of Meteorological Observations or Papers are from time to time received by the Society for distribution; and *are forwarded free to Members*.

The 'Proceedings' of the Society are published and sold by Taylor and Francis, Red Lion Court, Fleet Street, E.C.

The Society possess a Library, which is available to Members. The President, N. Beardmore, Esq., has kindly received it in his rooms, 30 Great George Street.

The address of the Treasurer, H. Perigal, Esq., to whom subscriptions may be paid, is 57 Warren Street, Fitzroy Square, W.

1863, January 1.

JAMES GLAISHER, F.R.S.,
Dartmouth Place, Blackheath, S.E.
CHARLES V. WALKER, F.R.S.,
Fernside, Redhill.
Secretaries.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

Vol. I.] 1862, NOVEMBER 19. [No. 5.

N. BEARDMORE, Esq., C.E., F.R.A.S., President, in the Chair.

Charles Coles Adley, Esq., Assoc. Ins. C.E., Telegraph Engineer to East Indian Railway, 68 Harcourt Street, Dublin;
Henry Coxwell, Esq., Lower Tottenham;
Robert Cramp, Esq., 16 Chapel Place, Ramsgate;
Henry Crofton, Esq., Inchinaffa, Ashford, County Wicklow;
Richard Hodgson, Esq., F.R.A.S., Chingford, Essex;
W. F. Ingelow, Esq., 15 A Holland Street, Kensington;
John Lees, Esq., Reigate;
T. M. Mackay, Esq., 24 Leinster Gardens, Hyde Park;
Rev. C. Maxwell, B.A., Rector and Rural Dean, Leckpatrick, Strabane;
George Kingston Oliver, Esq., C.E., Kingston, near Arundel, Sussex;
Capt. G. W. Preedy, R.N., C.B., Nutley, Plymouth;
Sergeant Sylvester, Army Medical Corps, Fort Pitt, Chatham;
John Thurstans, Esq., 21 Church Street, Wolverhampton;
Charles Tomlinson, Esq., Lecturer on Physical Science, King's College School, 12 Bedford Place, Ampthill Square, N.W.;
Major Michael Foster Ward, Castle House, Calne;
A. W. Wills, Esq., Tettenhall, Wolverhampton;
were balloted for and duly elected Members of the Society.

XXIII. *On the Meteorological Observations made in Eight Balloon Ascents.* By James Glaisher, Esq., F.R.S., Secretary.

Amongst meteorologists, the desire to be among, and to get above, the clouds has been always great, as promising the only satisfactory means of determining the laws of the decrease of temperature with increase of elevation under different states of the sky, the laws of moisture, the circumstances of each formation of cloud, the heights at which they take place, their thickness and the space which separates them, as well as to determine the many currents which may simultaneously exist in the atmosphere. The only sure way of getting into the clouds, passing through and getting above them, is by means of balloons: hence the interest and value of balloon experiments for meteorological purposes.

Very many have been the attempts to attain the art of ascending into the air, and very numerous experiments have been made to solve the problem of atmospheric buoyancy; indeed, I may say that such researches and experiments extended over nearly 2000 years, till the art of aërial navigation was discovered in France in the year 1782.

In that year, two brothers, Stephen and Joseph Mongolfier, who who had noticed the rising of smoke, concluded that, if they could confine smoke in a very light bag, it would rise in the air and carry the bag with it. Accordingly they constructed a bag of paper, leaving the lower part open, to which they applied burning paper with the view of producing smoke; upon which it began to expand, and in a few minutes sustained itself by being held at its lower part, and shortly afterwards, on being released, rose to the ceiling of the room, where it remained a short time, much to their delight. Hence the origin of the fire-balloon.

In the year 1766, Henry Cavendish discovered that inflammable air, or hydrogen gas, was lighter than air; and it immediately occurred to Dr. Black of Edinburgh that a thin bladder, filled with hydrogen gas, would rise of itself.

In Dr. Thomas Thomson's 'History of Chemistry,' vol. i., there is the following anecdote of Dr. Black:—"Soon after the appearance of Mr. Cavendish's paper on hydrogen gas, in which he made an approximation to the specific gravity of that body, showing that it was at least ten times lighter than common air, Dr. Black invited a party of his friends to supper, informing them that he had a curiosity to show them. Dr. Hutton, Mr. Clarke of Eldon, and Sir George Clarke of Pennicuick were of the number. When

the company invited had assembled, he took them into a room, where he had the allantois of a calf filled with hydrogen gas; and upon setting it at liberty, it immediately ascended and adhered to the ceiling. The phenomenon was easily accounted for: it was taken for granted that a small black thread had been attached to the allantois, that the thread passed through the ceiling, and that some person in the apartment above, by pulling the thread, elevated the allantois to the ceiling and kept it in its position. The explanation was so probable, that it was acceded to by the whole company, though, like many other plausible theories, it turned out wholly unfounded; for when the allantois was brought down, no thread whatever was found attached to it. Dr. Black explained the cause of the ascent to his admiring friends; but such was his carelessness of his own reputation and of the information of the public, that he never gave the least account of this curious experiment even to his class, and more than twelve years elapsed before this obvious property of hydrogen gas was applied to the elevation of balloons."

On August 26, 1783, M. Charles, Professor of Natural Philosophy, filled a bag, 12 feet in diameter, with hydrogen gas; and when liberated, it rose to a height of 100 feet, being retained there by ropes; but on the next day it was liberated, and allowed to rise freely, when, in the presence of an enormous crowd, it ascended to a height exceeding 3000 feet.

Thus two original kinds of balloon were invented nearly at the same time, one called fire-balloons, filled with rarefied air, and the other air-balloons, inflated with hydrogen gas.

The results attained by the many experiments which were made during the years 1782 to 1785 having proved that a balloon would raise great weights, and continue for a long time thus suspended, caused great excitement over Europe and America, and particularly in France.

There became a general desire to explore the higher regions of the air, and to pursue meteorological, magnetical, and other researches in the lofty regions of the atmosphere; and the invention of the balloon was looked upon as most important for these ends, and likely to produce great consequences. It was not, however, as far as I know, till the beginning of this century that any ascents were made for scientific purposes. In the years 1803 and 1804, M. Robertson made three ascents from St. Petersburg, for the purpose of physiological, electrical, and magnetical experiments. On August 23, 1804, MM. Gay-Lussac and Biot ascended from

Paris for a similar purpose; they reached a height of 13,000 feet and came down safely, finding no difference in their experiments in magnetism, electricity, and galvanism from those made on the earth—a sad disappointment of the expectations of the scientific world.

On the 15th of September following, Gay-Lussac ascended to a height of 22,977 feet. He found the time of the vibration of a magnet to be less than on the earth; his respiration was affected; the temperature of the air decreased from 82° to 15°, and its humidity very rapidly. He filled some glass bottles with air from the higher regions; and noticed that the sky was deep blue. The readings of his thermometer were as follows:—

On the ground the temperature was				82°.
At an elevation of		9,930 feet it was		55.
"	"	11,275	"	52.
"	"	12,089	"	47.
"	"	12,500	"	51.
"	"	13,967	"	54.
"	"	14,174	"	50.
"	"	15,469	"	47.
"	"	15,746	"	44.
"	"	14,776	"	48.
"	"	16,381	"	41.
"	"	17,252	"	40.
"	"	18,069	"	37.
"	"	18,585	"	33.
"	"	16,498	"	34.
"	"	19,783	"	26½.
"	"	20,000	"	29.
"	"	20,119	"	26.
"	"	22,546	"	19.
"	"	22,851	"	15.

In 1806, Carlo Brioschi, Astronomer Royal at Naples, endeavouring to ascend higher than Gay-Lussac, the balloon burst; but its remnant happily checked the rapidity of the descent, and, falling in an open space, his life was saved; but Brioschi contracted a complaint which brought him to his grave. Balloons now became common.

A period followed of 46 years, during which I do not know of any systematic attempts to take scientific observations by means of balloons.

In the year 1852, Mr. Welsh, of the Kew Observatory, under the auspices of the British Association, made four ascents in the great Nassau balloon, with the veteran aëronaut Mr. Green, who had had the experience of 500 ascents.

On August 17, August 26, October 21, and November 10, he reached the respective heights of 19,500, 19,100, 12,640, and 22,930 feet—and took a series of observations in each ascent, from which he deduced, as far as temperature is concerned, "that the temperature of the air decreases uniformly with the height above the earth's surface until, at a certain elevation varying on different days, the decrease is arrested; and for a space of 2000 or 3000 feet the temperature remains nearly constant, or even increases by a small amount—the regular diminution being afterwards resumed, and generally maintained at a rate slightly less rapid than in the lower part of the atmosphere, and commencing from a higher temperature than would have existed but for the interruption noticed."

The facts recorded by Gay-Lussac, relative to the decline of temperature with increase of elevation, appeared to confirm the theory based upon observations made on mountain-sides, which assigns for gradation of temperature in the atmosphere a decrease of 1° for every increase of height of 300 feet; and the deductions of Mr. Welsh from his experiments tended to the confirmation of the same theory, though somewhat modified.

Therefore, up to the present time, the high expectations entertained on the discovery of the balloon have never been realized; and there has been a constant desire, both in France and England, ever since its invention, to apply the balloon to those philosophical experiments whose solution cannot be made in a satisfactory manner without its use; and many committees have been appointed, and many grants of money made, by the British Association to this end ever since its formation.

The Committee appointed at Manchester (in September 1861) consisted of Colonel Sykes, Lord Wrottesley, Sir J. Herschel, General Sabine, Dr. Lloyd, Admiral FitzRoy, Dr. Lee, Dr. Robinson, The Astronomer Royal, Mr. Gassiot, Dr. Tyndall, Professor Miller, and myself.

The objects determined to be pursued by means of balloons by this Committee were as follows:—

Objects of the Experiments.

The *primary* objects were—

The determination of the temperatures of the air, and its hygrometrical states, at different elevations up to five miles.

The *secondary* objects were—

To compare the readings of an aneroid barometer with those of a mercurial barometer up to five miles.

To determine the electrical state of the air.

To determine the oxygenic state of the air by means of ozone-papers.

To determine the time of vibration of a magnet on the earth and at different distances from it.

To determine the temperature of the dew-point by Daniell's dew-point hygrometer, Regnault's condensing hygrometer, and by the use of the dry- and wet-bulb thermometers as ordinarily used, and by their use when under the influence of the aspirator, so that considerable volumes of air were made to pass over their bulbs, both at different elevations, as high as possible, but particularly up to those heights where man may be resident, or where troops may be located, as in the high lands and plains of India, with the view of ascertaining what confidence may be placed in the use of the dry- and wet-bulb thermometers, by comparison of the results found from them with those found directly by Daniell's and Regnault's hygrometers, and to compare together the results found from the two hygrometers.

To collect air at different elevations.

To note the height and kind of clouds, their density and thickness at different elevations.

To determine the rate and directions of different currents in the atmosphere.

To make observations on sound.

To note atmospherical phenomena in general, and to make general observations.

Circumstances of the Ascents, and General Observations.

The ascents were all made with Mr. Coxwell's large balloon; three from Wolverhampton, four from the Crystal Palace, Sydenham, and one from Mill Hill, near Hendon, where the balloon had fallen the previous evening, and been anchored during the night.

Observing-Arrangements.

One end of the car was occupied by Mr. Coxwell; near the other, in front of myself, was placed a board or table, the extremities of which rested on the sides of the car. Upon this board were placed suitable framework to carry the several thermometers, hygrometers, magnet, aneroid barometer, &c. A perforation through it admitted the lower branch of the mercurial barometer to descend below, leaving the upper branch at a convenient height for observing. A watch was set to Greenwich time, and placed directly opposite to myself. The central space of the table was occupied by my note-book; the aspirator was fixed underneath the centre of the board, so as to be conveniently workable by either my feet or hands. Holes were cut in the board to admit the passage of the flexible tubes, one of which passed to Regnault's hygrometer, and the other to the place of the dry- and wet-bulb thermometers previously referred to, both the tubes being furnished with stopcocks.

Ascent from Wolverhampton, July 17th. (Plate V.)

The weather previously had been bad for a long time, and the ascent had been delayed some days in consequence; the wind was still blowing strongly from the W., and considerable difficulty was experienced in the preliminary arrangements, and no instrument could be placed in position before starting.

The ascent took place at $9^h 43^m$ A.M., with an air-temperature of 59°, and dew-point 55°; and at once the balloon was quiescent. A height of 3800 feet was, however, reached before an observation could be taken, when the temperature of the air was 45°, and that of the dew-point 33°; at 4000 feet clouds were entered, which were left at 8000 feet, the temperature of the air having fallen to 32°, and that of the dew-point to $27°\frac{3}{4}$. A height exceeding 10,000 feet had been passed before all the instruments were in working order; the temperature of the air here was 26°, and of the dew-point 19°, and a deep-blue sky overhead, without a single cloud upon its surface. Between this point (10,000 feet) and 13,000 feet there was only a slight variation of temperature—not more than 0°·3 or 0°·4. During the time of passing through this space, both Mr. Coxwell and myself put on additional clothing, feeling certain that we should experience a temperature below zero before we reached five miles high; but, to my surprise, at the height of 15,500 feet the temperature, as shown by all the sensi-

tive instruments, had risen to 31°, and the dew-point to 25°, which continued steadily increasing till at a height of 18,800 feet it was 37°, and the dew-point 24°; but at 19,500 feet it had lost 1°. For eight minutes the balloon remained at about the same elevation; but the temperature of the air rose to 42°, and that of the dew-point to 24°; and on the balloon falling during the next ten minutes to 19,000 feet, the temperature decreased to 34°, and the dew-point to 21°. The balloon now rose to a height of five miles, and the temperature decreased with great rapidity to 16°, about 1° per minute, dew-point to below −12°. When the balloon had attained a height of about four miles, I wished to descend for one or two miles and then reascend; but Mr. Coxwell, who had been watching its progress with reference to the clouds below, felt certain that we were going too near the Wash to permit us to make a dip and then reascend; prudence therefore caused us to abandon the attempt.

Our descent began a little after 11^h A.M., Mr. Coxwell experiencing considerable uneasiness at our too close vicinity to the Wash; the temperature quickly increased, and at the height of 23,700 feet was 27°; 1300 feet lower it was still the same; but at 16,400 feet it increased to 30°. We fell rapidly to 12,000 feet, with a temperature of 34°, and almost immediately afterwards entered a dense cloud, so dense indeed that the balloon could not be seen from the car; it proved to be no less than 8000 feet in thickness. The last reading taken was 37°¾ at the height of 9700 feet, at 20 minutes to 12, the balloon having fallen 6700 feet in 3 minutes. We still continued descending with great rapidity; and although Mr. Coxwell had reserved a large amount of ballast, which he discharged as quickly as possible, in order to check the rapidity of descent, yet notwithstanding all his exertions, as we had collected weight from the saturation of the balloon, and the condensation of the immense amount of vapour through which we had passed, it was necessarily very rapid; and we came to the earth at 10 minutes to 12 with a very considerable shock, which broke all the instruments I had been unable to pack up. Having for some little time before discharged our sand, the amount we had at our disposal at the height of 5 miles was fully 500 lbs.; this seemed to be more than ample, and when compared with that retained by Gay-Lussac, viz. 33 lbs., and by Rush and Green, when the barometer-reading was 11 inches, viz. 70 lbs., seemed indeed to be more than we could possibly need; yet it proved to be insufficient. The descent took place at Langham, near Oakham, in Rutlandshire, in a meadow

near the residence of E. G. Baker, Esq., from whom we received the utmost attention.

The path of the balloon and the successive temperatures of the air, as observed in this ascent, are shown in Diagram I.

Explanation of the Diagrams. I. to VIII. (Plates V. to XIII.) *show the Path of the Balloon in each ascent.*—In these diagrams the vertical lines are separated from each other by intervals of 4 minutes of time; the horizontal lines, in those of July 17th, August 18th, August 21st, and September 5th, are separated from each other by intervals of 1000 feet, and in those of July 30th, August 20th, September 5th, and September 8th by intervals of 200 feet. The thick wavy line in all shows the path of the balloon; the numbers near it, the temperatures of the air as observed at these heights. The numbers on the sides indicate the height in feet; and the number on the top, the times the balloon was at these elevations.

Ascent from the Crystal Palace, July 30th. (Plate VI.)

In this ascent a table was fixed to the side of the car, partly projecting within and partly without. The instruments were carried by a framework fixed to the part of the table outside, so as to be beyond the influence of the occupants of the car. My note-book, watch, and aneroid barometer rested on the inner part of the table. The wind was blowing gently from the South-West, enabling the instruments to be fixed before starting; and at $4^h\ 40^m$ P.M. the balloon left the earth. The temperature declined instantly. Observations were taken every minute or half-minute from the time of ascent to the time of descent. On the ground, before starting, the temperature of the air was 68°, and of dew-point 50°; at the height of 1000 feet the temperature had declined to 62°, and the dew-point to 44°; at 3000 feet it was 53°, and dew-point 41°; at 5000 feet the temperature of the air had declined to 49½°, and that of the dew-point to 37°; and at the height of one mile the temperature was more than 23° less than on the earth.

The readings of one barometer were made by W. F. Ingelow, Esq., and he also assisted me in indicating the first appearance of dew on the hygrometer.

A height of 7000 feet was reached by six o'clock, when the temperature was found to be 44°, and the dew-point 32°. The descent commenced at about a quarter past six. It was rather rapid. At 5000 feet the temperature of the air had increased to 47½°, and the dew-point to 37°; and at 2000 feet to 59°, and dew-point 42¼°.

The earth was reached at the village of Singlewell, near Gravesend, at about 6^h 30^m P.M.

The path of the balloon and successive temperatures of the air, as observed in this ascent, are shown in Diagram II. (Plate VI.).

Ascent from Wolverhampton, August 18*th.* (Plate VII.)

The weather on this day was favourable; there was but little wind, and that was blowing from the N.E. By noon the balloon was nearly inflated; and as it merely swayed gently in a light wind, all the instruments were fixed before starting. At 3 minutes past 1^h P.M., Mr. Coxwell pulled the spring-catch; for a moment the balloon remained motionless, and then rose steadily and almost perpendicularly. This ascent was all that could be desired.

On the ground, the temperature was 68°, and dew-point 57°; at 1200 feet, it was 60°, with dew-point 52½°; between 3000 and 4000 feet we passed through a fine cumulus cloud, and then emerged into a clear space with a beautiful blue sky above, dotted over with cirrus clouds, the temperature regularly decreasing to 48° at 5500 feet, and dew-point 40°, and to 38½° at 11,800 feet, and dew-point 26°. Mr. Coxwell now discharged some gas, and we came down to 3200 feet at 1^h 48^m P.M., with the temperature 56°, and dew-point 47°.

A gradual ascent then took place, the temperature at about 5000 feet being 55°, and dew-point 41½°, and the balloon surrounded with cumulus cloud; at nearly 10,000 feet the temperature was 48°, and dew-point 27°; at 14,000 feet, it was 34°, and dew-point 24°, and continued falling to 25° at 21,000 feet, and dew-point −8°, and to 24° at 23,600 feet: it was then nearly 3 o'clock. Here a consultation took place as to the prudence of discharging more ballast, or retaining it so as to ensure a safe descent; ultimately it was determined not to go higher, as some clouds, whose thickness we could not tell, had to be passed through. We continued at the elevation of between 23,600 and 22,000 feet for nearly 20 minutes, the temperature being between 24° and 25°, and dew-point less than −12°. The descent then commenced, and in about a quarter of an hour we had fallen to 18,200 feet, with the temperature 33°, and dew-point 11½°; at two miles it was 41°, and dew-point 15°. At 8300 feet, the temperature of air was 50½°, and dew-point 34½°. Between this and 5000 feet, two strata of clouds were passed through—one between 6000 and 7000 feet, and the other between 5000 and 6000. At about 4500 feet we passed into a thick mist, which was 1500 feet in thickness, with a tempe-

rature of 51°, and dew-point about the same; and reached the earth about 5 minutes past 4h P.M., temperature 67°, and dew-point 57°, at Solihull, about seven miles from Birmingham.

The path of the balloon and successive temperatures of the air, as observed in this ascent, are shown in Diagram III. (Plate VII.).

Ascent from the Crystal Palace, August 20th. (Plate VIII.)

The air was almost calm; the instruments were all fixed before starting; and the balloon left the Crystal Palace at 6h 26m P.M., the temperature being 66°, and the dew-point 54°. In ten minutes we had gained an altitude of 2400 feet, with a temperature of 56°, and dew-point 50°. At 6h 43m, at a height of 4200 feet, a thick mist or thin cloud was entered, the temperature being 50°, and the dew-point 46°; and at the height of nearly 4400 feet it increased to 51°, and dew-point to 48°. This elevation and temperature were maintained for about five minutes, when a descent was made to 3600 feet, with the same temperature and dew-point, although the thermometer had fallen a degree in passing through the mist or cloud. Kennington Oval was now in sight. An ascent was then made to 4350 feet, with temperature 47°, and dew-point 44°; and a descent of 100 feet to a temperature of 48°, and dew-point 46°, St. Mark's Church, Kennington, being exactly beneath us; the hum of London was heard. A descent was made gradually to 1200 feet, with a temperature of 57½°, and dew-point 49°, at 7.20 P.M.; shouting was heard of people below, who saw the balloon. An ascent was again made to about 2600 feet, temperature being 54¾°, and dew-point 51°. The river was dull in its look; but the bridges which spanned it, as well as street after street, as they were lit up, and the miles of lights, sometimes in straight lines, sometimes winding like a serpent, or in some places forming a constellation at some place of amusement, associated as this appearance was with the deep sound or rather roar of the traffic of the metropolis, constituted a truly remarkable scene.

For a considerable time, Kennington Oval and Millbank Penitentiary were in sight; and it seemed as though we could not get away from them. At 7h 40m Mr. Coxwell determined to ascend above the clouds; we were then 2900 feet high, with a temperature of 53½°, and dew-point 46°. In 8 minutes we were 5100 feet high; temperature 45°, and dew-point 42°. It was very dark, looking down; but there was a clear sky above, and a beautiful gleam of light appeared. We still ascended till the clouds were below us, tinged and coloured with a rich red; we were at this time 5900

feet high, and the temperature 43°. We again descended to 5300 feet, temperature 44°; the striking of a clock and the tolling of a bell were heard. It was quite dark below; but the sun tinged the tops of the clouds. At $8^h\ 5^m$ P.M. we were quite above the clouds, and it became light again; the hum of London gradually died away. By this time the temperature had increased to 55°, our height being 7400 feet. After this we descended, and it became too dark to read the instruments. London again was seen, very different indeed in its appearance from when we could pick out every square, street, or bridge by its lights: now, as seen through the mist, it had the appearance of a large conflagration of enormous extent; and the sky was lit up for miles around. After a time, the lowing of cattle was heard, and we seemed to have left London; so Mr. Coxwell determined to pass through the clouds, and examine the country beneath. We passed from the comparative light above to the darkness beneath, momentarily becoming darker, and found ourselves some little distance from London. It is in the management of a descent, under circumstances like these, that the skill of the aëronaut is taxed to the utmost. The darkness precluded the use of the grapnel on this occasion, and the possibility of observing the nature of the ground till skirting the tops of the trees. Mr. Coxwell proved himself perfectly competent, the balloon ascending and descending at his will, and it shortly touched the ground, so gently that one was scarcely aware of the contact, in the centre of a field at Mill Hill, about a mile and a half from Hendon; and it was resolved to anchor the balloon for the night, with the view of making an early ascent the next morning.

The path of the balloon and successive temperatures of the air, as observed in this ascent, are shown in Diagram IV. (Plate VIII.).

Ascent from Mill Hill, near Hendon, August 21st. (Plate IX.)

By $4^h\ 30^m$ A.M. the instruments were replaced, and the earth was again left. It was a dull, warm, cloudy morning, still rather dusk, the sky covered with cirro-stratus clouds; the air-temperature nearly 61°, dew-point 58½°. There were in the car, besides Mr. Coxwell and myself, Captain Percival of the Connaught Rangers, Mr. Ingelow, and my son. The ascent was at first slow; at $4^h\ 38^m$ a height of 1000 feet was reached, the air-temperature being 58°, and the dew-point 52°. At $4^h\ 41^m$ there was a break in the clouds to the E., with gold and silver lines of light. At $4^h\ 51^m$ the temperature of the air was 50°, and dew-point 44°. Scud was below,

and cumuli on the same level, viz. 3500 feet; black clouds were above, and the mist was creeping along the ground. At $4^h\,55^m$ the first mile was passed; the temperature of the air was 43°, and dew-point 41°: clouds were entered soon after. At $4^h\,57^m$ a white mist enveloped the balloon, &c.; the temperatures of the air and dew-point were alike, indicating complete saturation. The light rapidly increased, and, gradually emerging from the dense cloud into a basin surrounded by immense black mountains of cloud rising far above us, shortly afterwards there were deep ravines of grand proportion beneath open to the view. The sky immediately overhead was dotted with cirrus clouds. As the balloon ascended, the tops of the mountain-like clouds were observed to be tinged with silver and gold. At $5^h\,1^m$ they were level with the car, and the sun appeared flooding with light all that could be seen both right and left for many degrees, tinting with orange and silver all the remaining space. It was a glorious sight. By $5^h\,10^m$ a height of 8000 feet had been attained, and the temperature had increased to $37\frac{1}{4}$°, and dew-point $24\frac{3}{4}$°. The ascent still continued, but more quickly, as the sun's rays fell upon the balloon, each instant opening to view deep ravines and a wonderful sea of clouds. Here arose shining masses of cloud in mountain-ranges, some rising perpendicularly from the plains with summits of dazzling brightness, some pyramidal, others undulatory. Nor was the scene wanting in light and shade; each large mass of cloud cast a shadow, thereby increasing the number of tints and beauty of the scene.

By $5^h\,16^m$ a height of two miles had been reached; the temperature of the air was 32° F., and dew-point 13°; the air was therefore dry. By $5^h\,31^m$ a height of nearly three miles was reached; the temperature of the air was 23°, and of the dew-point —23°, the temperature decreasing to 19° by $5^h\,34^m$. This elevation was maintained for half an hour, during which time the temperature increased to 24°, as the sun's altitude increased. Shortly after six o'clock the descent commenced; the temperature, which had been as high as 27°, had decreased to 23°. At $6^h\,13^m$, when two and a quarter miles high, a train was heard; by $6^h\,20^m$, when two miles high, the temperature had increased to 39°, and the dew-point to 19°. At this time it was noticed that, when the ear was on the same level as the watch, the ticking of the latter was inaudible; but when the ear was above it the sound was greatly increased. By $6^h\,24^m$ the temperature had increased to 43°, that of the dew-point to 21°. The shadow of the balloon, encircled by an oval of prismatic colours, was here very vivid and distinct, and increased in

vividness till a cloud was entered at 6^h 29^m, which was left at 6^h 33^m. The earth was now in sight, without a ray of sunlight falling upon it; the temperature of the air increased to 56° at 1000 feet, and to 62° on reaching the ground, which took place very gently at Dunton Lodge, near Biggleswade, the seat of Lord Brownlow.

The path of the balloon and successive temperatures of the air, as observed in this ascent, are shown in Diagram V. (Plate IX.).

Ascent from the Crystal Palace, September 1st. (Plate X.)

The wind on this day blew from the E.N.E.; the sky was almost covered with cirro-stratus cloud; the horizon was moderately clear. The balloon left the earth at 4^h 52^m P.M., the temperature being 64°; and reached a height of nearly 3000 feet in 6 minutes, temperature 51°, dew-point 43°. It then ascended to 3500 feet, descended to 3300 feet, and again ascended to nearly 3600 feet, with the temperature varying between 50° and 51°, and dew-point 40° and 41°. At 3700 feet the temperature was 49°, and dew-point 38½°; the balloon descended a little, and then rose to 4000 feet, with the temperature 47°, dew-point 37½°. Another dip was made to 3700 feet, temperature 48°; and then the balloon rose to 4200 feet, temperature 46°, dew-point 37°. Clouds were here observed forming, and following the whole course of the Thames, from the Nore up to the higher parts of the river, and extending but little beyond its sides; the clouds were parallel to the river, following all its windings and bendings. The Astronomer Royal has often seen this phenomenon over the part of the river commanded by the Royal Observatory; but it was scarcely expected that clouds throughout its whole course would have formed so simultaneously and uniformly. On referring to the state of the tide, it was found to be just high water at London Bridge about this time, connecting the formation with the warm water from the sea.

At this time we were higher than all clouds near us, excepting the uniform stratus cloud above, which we never approached; and it was noted that the upper surface of the lower clouds were bluish white, the middle portion the pure white of the cumulus, and from which rain was falling, and, as we afterwards learned, had been falling all the afternoon.

In this ascent, the observations of the barometers and Daniell's hygrometer were made by Mr. J. MacDonald, the Assistant Secretary of this Society.

The path of the balloon and successive temperatures of the air, as observed in this ascent, are shown in Diagram VI. (Plate X.).

Ascent from Wolverhampton, on September 5th. (Plate XI.)

This ascent had been delayed, owing to the unfavourable state of the weather. It commenced at $1^h\ 3^m$ P.M., the temperature of the air being 59°, and the dew-point 48°; at the height of one mile it was 41°, and dew-point 38°; shortly afterwards clouds were entered of about 1100 feet in thickness. Upon emerging from them at $1^h\ 17^m$, I tried to take a view of their surface with the camera; but the balloon was ascending too rapidly, and gyrating too quickly to enable me to do so. All that would have been necessary would have been a momentary exposure, as the flood of light was so great and the dry plates with which I had been furnished by Dr. Hill Norris so sensitive. The height of two miles was reached by $1^h\ 21^m$ the temperature of the air had fallen to 32°, and the dew-point to 26°. The third mile was passed at $1^h\ 28^m$, with an air-temperature of 18°, and dew-point 13°.

The fourth mile was passed at $1^h\ 39^m$, with an air-temperature of 8°·5, dew-point 6°; and the fifth about ten minutes later, with an air-temperature of 5°, and dew-point —36°.

Up to this time I had experienced no particular inconvenience: when at a height of 26,000 feet I could not see the fine column of mercury in the tube; then the fine divisions on the scale of the instrument became invisible. At this time I asked Mr. Coxwell to help me to read the instruments, as I experienced a difficulty in seeing them. In consequence of the rotatory motion of the balloon, which had continued without ceasing since the earth was left, the valve-line had become twisted, and he had to leave the car and mount into the ring above to adjust it. At this time I had no suspicion of other than temporary inconvenience in seeing. Shortly afterwards, I laid my arm upon the table possessed of its full vigour, and, on being desirous of using it, I found it powerless: it must have lost its power momentarily. I tried to move the other arm, and found it to be powerless also. I then tried to shake myself, and succeeded in shaking my body. I seemed to have no legs; I could only shake my body. I then looked at the barometer, and whilst doing so my head fell on my left shoulder. I struggled, and shook my body again, but could not move my arms. I got my head upright, but for an instant only, when it fell on my right shoulder, and then I fell backwards, my back resting against the side of the car, and my head on its edge; in this position my eyes were directed towards Mr. Coxwell in the ring. When I shook myself I seemed to have full power over

the muscles of the back, and considerable power over those of the neck, but none over either my arms or my legs; in fact, I seemed to have none. As in the case of the arms, all muscular power was lost in an instant from my back and neck. I dimly saw Mr. Coxwell in the ring, and endeavoured to speak, but could not do so, when in an instant intense black darkness came—the optic nerve finally lost power suddenly. I was still conscious, with as active a brain as at the present moment whilst writing this. I thought I had been seized with asphyxia, and that I should experience no more, as death would come, unless we speedily descended; other thoughts were actively entering my mind, when (like every other symptom) I suddenly became unconscious, as going to sleep. I cannot tell anything about the sense of hearing; the perfect silence of the regions six miles from the earth (and at this time we were between six and seven miles high) is such that no sound reaches the ear.

My last observation was made at 29,000 feet, about $1^h 54^m$. I suppose two or three minutes, fully, were occupied between my eyes becoming insensible to seeing fine divisions and $1^h 54^m$, and then that two or three minutes more passed till I was insensible; therefore I think this took place about $1^h 56^m$ or $1^h 57^m$. Whilst powerless, I heard the words "temperature" and "observation," and I knew Mr. Coxwell was in the car, and speaking to me and endeavouring to arouse me; therefore consciousness and hearing had returned. I then heard him speak more emphatically; but I could not see, speak, or move. Then I heard him again say, "Do, try now, do." Then I saw the instruments dimly, then Mr. Coxwell, and very shortly saw clearly. I rose in my seat, and looked round, as though waking from sleep, and said to Mr. Coxwell, "I have been insensible;" and he said, "You have, and I, too, very nearly." I then drew up my legs, which had been extended out before me, and took a pencil in my hand to begin observations. Mr. Coxwell told me that he had lost the use of his hands, which were black; and I poured brandy over them.

I resumed my observations at $2^h 7^m$. I suppose three or four minutes were occupied from the time of my hearing the words "temperature" and "observation" till I began to observe; if so, then returning consciousness came at $2^h 4^m$, and this gives about seven minutes for total insensibility.

Mr. Coxwell told me, that on coming from the ring he thought for a moment I had lain back to rest myself; that he spoke to me without eliciting a reply; that he then noticed that my legs pro-

jected, and my arms hung down by my side; that my countenance was serene and placid, without the earnestness and anxiety he had noticed before going into the ring; and then it struck him I was insensible; he wished then to approach me, but could not, and he felt insensibility coming over himself; that he became anxious to open the valve, but in consequence of having lost the use of his hands he could not, and ultimately did so by seizing the cord with his teeth, and dipping his head two or three times.

No inconvenience followed this insensibility; and when we dropped, it was in a country where no conveyance of any kind could be obtained, so that I had to walk between seven and eight miles.

In descending, when we arrived at the height of 12,000 feet, the temperature had risen to 26½°, and the dew-point to 2°; at 5500 feet it had risen to 47°, and the dew-point to 21¼°, and to 57¼° on the ground. The descent was at first very rapid; we passed downwards three miles in nine minutes; the balloon's career was then checked, and finally came down on a spot in the centre of a large grass-field belonging to Mr. Kersall, at Cold Weston, seven and a half miles from Ludlow. On descending, a number of country people stood in a corner of the field, like a flock of frightened sheep; and it was not till after a good deal of coaxing in very plain English that any one, excepting Mr. Kersall, would approach us. The country people seemed to think we were not mortal.

In this ascent, six pigeons were taken up. One was thrown out at the height of three miles; it extended its wings and dropped as a piece of paper. A second at four miles flew vigorously round and round, apparently taking a dip each time. A third was thrown out between four and five miles, and it fell downwards. A fourth was thrown at four miles, on descending; it flew in a circle and shortly after alighted on the balloon. The two remaining pigeons were brought to the ground: one was found to be dead; and the other, after a quarter of an hour, flew towards Wolverhampton.

I have already said that my last observation was made at the height of 29,000 feet. At this time ($1^h\ 54^m$) we were ascending at the rate of 1000 feet per minute; when I resumed observations, we were descending at the rate of 2000 feet per minute. These two positions must be connected, taking into account the interval of of time, viz. 13 minutes; and on these considerations, the balloon must have been fully 36,000 or 37,000 feet. Again, a minimum thermometer read —12°, and this would give a height of 37,000 feet: also Mr. Coxwell saw the centre of the aneroid barometer, its blue hand, and a fixed rope were all in the same straight line; and

this gave a reading of 7 inches, and leads to the same result: therefore these independent means lead to an elevation of fully seven miles.

The path of the balloon and the successive temperatures of the air, as observed in this ascent, are shown in Diagram VII. (Plate XI.).

Ascent on September 8*th, from the Crystal Palace.* (Plate XII.)

The sky was for the most part obscured by clouds. The ascent took place at $4^h 47^m 28^s$, the temperature of the air being 67°, and the dew-point 61°. At $4^h 52^m$ the height of half a mile was reached, with a temperature of 59°, and dew-point 54°. At $4^h 55^m$ clouds were entered, but not passed. The temperature fell to 51½°, and dew-point to 49°, at 4300 feet. An ascent was then made to 4800 feet, the temperature of the air fell to 50½°, and the dew-point to 48°, but still in the clouds; and then a descent to 3300 feet, passing out of the clouds, downwards, at $5^h 1^m$, with an air-temperature of 52°, dew-point 50°. An ascent was then made, and the clouds reached at 4200 feet, and with the same temperature; the clouds were left at 4500 feet, emerging into a basin with a blue sky above: the sun shone beautifully, the balloon rose quickly, and the temperature increased from 51°, on leaving the cloud, to 57° at the height of a mile; and to 60° at 5400 feet, the dew-point temperature being 40°. A descent was made, and the clouds entered at 5000 feet, with a temperature of 51°, dew-point 45°, and left at 4400 feet. The temperature then rose to 61°, and the dew-point 60°, at the height of 800 feet. At this time the Thames was crossed at Gravesend, the passage across occupying 121 seconds. An ascent of half a mile then took place, Tilbury Fort was passed at the distance of two miles, and, as examined by means of an opera-glass, every part of its interior was distinctly seen, and could have been drawn and described. The descent took place four miles from the Fort, at $6^h 10^m$ P.M.

In this ascent Mr. W. C. Nash, of the Magnetical and Meteorological Department of the Royal Observatory, Greenwich, took the observations of the barometers and Daniell's hygrometer.

The path of the balloon and the successive temperatures of the air, as observed in this ascent, are shown in Diagram VIII. (Plate XII.).

The observations of temperature and dew-point, taken in the several ascents, have been formed into groups, with the corresponding heights, forming the following series of Tables.

In these Tables, columns 1 and 2 contain the times of the

first and last observations in each group; column 3 contains the number of observations; column 4, the mean height above the level of the sea; column 5, the mean temperature; column 6, the mean temperature of the dew-point; column 7, the depression of the dew-point temperature below that of the air; and column 8, the degree of humidity.

For the individual observations, and discussion of each subject of research, see the Report of the British Association for the year 1862.

Means of Groups of the Observations of Temperature of the Air and of Dew-point Temperature at different heights in the Eight Balloon Ascents, with the differences between the two Temperatures and the Mean Degree of Humidity of each group.

July 17.

Time of		Groups.					
First Observation. A.M.	Last Observation. A.M.	No. of Observations.	Mean Height.	Mean Temperature.	Dew-point.	Differences between Air and Dew-point.	Degree of Humidity.
h. m. s.	h. m. s.		ft.	°	°	°	
9 42 0	....	1	490	59·0	51·4	7·6	76
9 47 0	....	1	3835	45·0	35·3	9·7	69
9 49 0	....	1	4467	43·0	32·0	11·0	65
9 51 0	....	1	5802	34·8	32·1	2·7	86
9 53 0	....	1	7980	32·5			
9 54 0	....	1	8065	31·8	27·8	4·0	81
9 55 0	....	1	8809	29·8	19·7	10·1	63
9 56 0	....	1	9598	26·2	17·6	8·6	62
9 58 0	10 2 0	2	11552	26·0	24·4	1·6	84
10 3 0	....	1	12709	26·0	20·8	5·2	78
10 4 0	10 5 0	2	13277	28·0	23·7	4·3	71
10 8 0	....	1	14544	31·0	23·8	7·2	74
10 11 0	....	1	15704	31·6	22·7	8·9	71
10 15 0	....	1	16914	32·0	22·7	9·3	79
10 25 0	....	1	18844	37·2	24·6	12·6	65
10 27 0	10 30 0	3	19402	37·5	21·7	15·8	52
10 35 0	....	1	19485	42·2	19·5	22·7	40
10 39 0	10 44 0	2	19358	35·3	21·5	13·8	55
10 47 0	....	2	20375	31·5	14·6	16·9	44
10 50 0	10 54 0	2	21425	21·4	−13·0	34·4	Degree of humidity very small indeed.
10 57 0	....	1	23949	17·5	No dew deposited on the hygrometer when cooled down to −16°.	Probably exceeding 30°.	
11 0 0	....	1	24746	16·0			
11 1 0	....	1	26177	16·0			
11 3 0	11 7 0	3	25042	17·2			
11 12 0	....	1	24547	23·7			
11 20 0	....	1	23868	27·0			
11 25 0	....	1	22337	27·2			
11 37 0	....	1	16282	29·7	9·4	20·3	40
11 38 0	....	1	12376	34·2	7·4	26·8	30
11 39 0	....	1	10539	37·0			
11 40 0	....	1	9882	37·8	18·0	19·8	43

August 18.

Time of		Groups.					
First Observation. P.M.	Last Observation. P.M.	No. of Observations.	Mean Height.	Mean Temperature.	Dew-point.	Differences between Air and Dew-point.	Degree of Humidity.
h. m. s.	h. m. s.		ft.	°	°	°	
0 56 0	....	1	490	67·8	54·6	13·2	64
1 5 0	....	1	1130	62·5	52·5	10·0	72
1 6 0	....	1	1419	60·0			
1 6 20	1 6 30	2	1754	57·7	53·1	4·6	82
1 7 0	....	1	2042	55·5	50·5	5·0	83
1 8 0	1 9 0	2	3526	51·2	49·6	1·6	95
1 10 0	....	1	4138	49·9			
1 11 0	....	1	4767	49·3	43·2	6·1	81
1 11 30	1 12 30	3	5376	48·2	38·8	9·4	70
1 14 0	....	1	6585	46·5			
1 15 0	....	1	7706	45·7			
1 17 0	....	1	8935	44·0	32·0	12·0	62
1 18 45	1 18 55	2	9966	41·7	29·1	12·6	60
1 20 0	1 21 0	3	11379	37·6	23·9	13·7	58
1 22 0	....	1	10840	41·8	25·2	16·6	50
1 24 0	1 25 0	5	9836	45·5	29·5	16·0	54
1 25 10	1 26 30	3	8342	47·2	30·6	16·6	52
1 27 0	1 33 0	3	7712	51·3	37·2	14·1	60
1 37 30	1 41 0	3	5589	53·6	37·6	16·0	57
1 41 30	1 43 0	2	4505				
1 46 0	1 48 0	2	3328	56·0	47·5	8·5	72
1 52 0	1 52 30	2	4340	55·0	45·0	10·0	70
1 55 0	1 58 0	2	5395	51·0	44·5	6·5	80
2 9 0	....	1	7886	50·5	38·6	11·9	65
2 10 0	2 13 40	4	8704	50·9	38·8	12·1	66
2 14 0	2 15 30	3	9798	49·6	34·1	15·5	57
2 17 0	....	1	10864				
2 20 0	....	1	11748				
2 21 0	2 23 0	3	12671	38·6	25·0	13·6	59
2 24 0	....	1	13852	34·1			
2 25 20	....	1	14434				
2 29 0	....	1	16339	27·8			
2 31 0	2 32 20	2	17239	28·3	− 0·7	29·0	
2 34 0	2 36 30	4	18299	29·0			
2 36 40	2 39 10	4	19269	26·2	− 2·0	28·2	
2 39 30	2 42 10	2	20179	25·3	− 5·0	30·3	
2 45 0	2 49 50	2	21111	24·4	− 6·1	30·5	
2 59 0	2 59 20	3	23252	24·2	−10·0	34·2	
2 59 40	3 5 0	6	22440	24·2	− 9·5	33·7	
3 6 0	....	1	23023				
3 7 0	3 12 30	2	22705	24·0	− 8·5	32·5	
3 13 15	....	1	21977	24·0			
3 13 40	3 18 30	2	22054	24·0			
3 25 0	....	1	21330	25·0			
3 33 0	....	1	15984	31·0			
3 34 0	....	1	13320	32·8	11·1	21·7	40
3 36 0	....	1	12453	38·0	13·3	24·7	34
3 39 0	....	1	10624	40·7	14·4	26·3	34
3 40 0	....	1	10224	45·5	14·4	31·1	28
3 41 30	3 43 0	2	8454	46·0			
3 43 30	....	1	7438	47·0	38·6	8·4	
3 46 10	....	1	6050	49·0			
3 46 30	3 50 10	4	5847	50·0			
3 50 20	3 51 0	2	4671	51·8	44·4	7·4	80
4 5 0	....	1	on the ground	67·0			

August 21.

Time of First Observation. A.M.	Time of Last Observation. A.M.	Groups. No. of Observations.	Mean Height.	Mean Temperature.	Dew-point.	Differences between Air and Dew-point.	Degree of Humidity.
h. m. s.	h. m. s.		ft.	°	°	°	
4 30 0	....	1	320	60·8	58·4	2·4	92
4 31 0	4 35 0	3	405	59·4	57·8	1·6	94
4 36 0	....	1	728	59·0	59·0	0·0	100
4 39 0	4 44 0	5	1331	56·9	51·2	5·7	82
4 45 0	4 49 0	2	2465	53·6	49·2	4·4	83
4 51 0	4 52 0	2	3730	48·4	42·7	5·7	82
4 53 0	4 55 0	2	4532	45·1	41·1	4·0	87
4 55 30	4 56 0	2	5260	42·6	40·6	2·0	93
4 57 0	4 57 30	2	5773	40·0	39·8	0·2	99
5 0 0	....	1	6510	38·5	36·0	2·5	91
5 3 0	5 5 0	3	6572	40·9	32·2	8·7	71
5 7 0	5 10 0	3	7308	39·6	28·5	11·1	65
5 11 0	5 14 0	3	8509	35·8	23·0	12·8	62
5 15 0	5 15 30	2	9337	33·9	19·4	14·5	54
5 16 0	5 18 0	3	10269	31·9	12·2	19·7	42
5 20 0	5 21 0	2	11419	28·8			
5 22 0	5 26 0	6	12531	23·6			
5 27 0	5 29 30	3	13305	23·7	− 8·4	32·1	The degree of humidity very small indeed.
5 30 30	5 32 0	3	13676	22·9	Certainly below −10°.	Fully 30°.	
5 32 30	5 34 30	3	13849	19·4			
5 35 0	....	1	14027	19·5			
5 36 0	....	1	13989	19·9			
5 36 30	5 38 30	4	14112	21·1			
5 40 0	5 44 0	4	14122	24·7			
5 44 30	5 46 15	5	14239	26·7	−12·9	39·6	
5 47 0	....	1	14355	27·6	−13·1	40·7	
5 48 0	5 51 0	5	14274	25·4	−15·0	40·4	
5 52 0	5 57 0	5	14234	23·5	−17·5	41·0	
5 57 30	6 1 0	6	14214	23·3	−25·2	48·5	
6 2 0	6 6 15	8	13440	24·5	−20·2	44·7	
6 12 0	6 13 0	3	12122	29·2	2·8	26·4	
6 13 30	6 15 0	4	11881	27·7	− 8·3	36·0	30
6 16 0	6 17 0	2	11322	31·8	6·6	25·2	32
6 18 0	6 18 30	3	10708	34·9	16·0	18·9	45
6 19 0	6 20 0	2	9793	37·0	18·4	18·6	45
6 22 0	6 24 0	3	8348	42·7	19·2	23·5	38
6 25 0	6 27 30	4	7416	43·8	20·5	23·3	39
6 28 0	6 29 0	3	7067	42·9	27·9	15·0	55
6 30 0	....	1	6884	43·0	33·1	9·9	68
6 31 0	6 33 0	5	6583	42·0	38·6	3·4	88
6 33 30	6 36 30	6	5326	42·8	37·9	4·9	84
6 37 0	6 38 0	4	4638	45·3	38·7	6·6	78
6 38 30	6 42 0	5	3543	48·4	42·8	5·6	81
6 42 15	6 44 0	3	2574	52·0	45·6	6·4	79
6 45 0	6 46 0	3	1690	55·3	48·1	7·2	78
7 10 0	....	1	513	61·8	41·1	20·7	68

September 5.

Time of		Groups.					
First Observation. P.M.	Last Observation. P.M.	No. of Observations.	Mean. Height.	Mean Temperature.	Dew-point.	Differences between Air and Dew-point.	Degree of Humidity.
h. m. s.	h. m. s.		ft.	°	°	°	
		1	490	59·5	48·4	11·1	65
1 5 0	1 5 20	3	846	58·1	50·3	7·8	76
1 5 30	1 6 0	2	1385	56·0	47·4	8·6	72
1 10 0	....	1	3660	45·5	41·5	4·0	87
1 11 0	1 12 0	3	4475	43·2	39·3	3·9	86
1 12 30	1 13 30	3	5469	39·5	36·9	2·6	92
1 14 30	1 17 0	4	6658	36·2	36·2	0·0	100
1 17 40	....	2	7575	39·5	30·2	9·3	70
1 21 0	....	1	9926	32·1	26·6	5·5	79
1 22 0	....	1	10770	31·2	26·9	4·3	82
1 24 0	....	1	12568	26·5	19·7	6·8	76
1 25 30	....	1	13715	25·5	22·3	3·2	89
1 27 0	1 28 0	2	15348	18·3			
1 29 0	1 29 20	2	16616	17·9	10·5	7·4	71
1 32 0	....	1	17590	15·5			
1 35 0	....	1	18890				
1 37 0	1 37 30	2	19145	15·7	−14·5	30·2	Very small indeed.
1 39 0	....	1	20393	8·5	−15·0	23·5	
1 40 30	....	1	21000	11·0	−15·0	26·0	
1 48 0	....	1	23976	0·0	−30·0 no dew		
1 49 0	....	1	25382	− 2·0	No dew deposited on the hygrometer when cooled down to −20°.		
1 51 0	....	2	26350				
1 53 +	....	....	28990	− 5·0			
2 0 0 inferred	......	....	36000	−12·0			
2 7 0	....	2	25318	− 2·0			
2 8 0	....	1	23021				
2 8 30	....	1	22654	2·0			
2 8 45	....	1	21650	11·0			
2 9 0	....	1	20018	17·0			
2 9 30	....	1	16015	18·0			
2 9 40	2 11 0	2	14475	22·5			
2 14 0	....	1	13520	24·5			
2 16 0	....	1	12250	26·5			
2 16 10	....	1	11150				
2 16 50	....	1	10071	31·1			
2 19 30	2 22 10	3	8310	37·6	15·5	22·1	39
2 23 20	....	1	7625	40·0	20·0	20·0	44
2 23 50	....	1	7260	40·0			
2 25 0	2 26 0	2	6725	42·0			
2 29 30	....	1	5500	47·0	21·8	25·2	36
2 32 0	....	1	4521	48·0			
2 38 0	....	1	3484	52·2	37·0	15·2	59
2 39 0	....	1	2260	54·0			

The results contained in these Tables of temperature of the air and dew-point were laid down in four figures in Diagram IX. (Plate XIII.).

July 17.

The principal results of this ascent, so far as temperature of the air and dew-point are concerned, are made evident to the eye in the first figure on Diagram IX. (Plate XIII.). In this it will be seen that the decline of temperature in the first mile exceeded 20°, that between 10,000 feet and 13,000 feet the same temperature prevailed, and then it increased, instead of decreased, from 26° to 43°, and then declined to 16° at five miles.

With respect to the temperature of the dew-point, it approaches that of the air in the cloud, but does not touch it; then departs from it, then approaches it again at 11,500 feet, and finally separates to an unknown extent at five miles, implying that the water there mixed with the air is very small indeed.

August 18.

The general results of this ascent, so far as temperature of the air and dew-point are concerned, are shown in the second figure on Diagram IX.

It will be seen here that more than 20° decline of temperature took place in the first mile, and not more than 2° in the last mile of ascent; that the temperature of the dew-point approached that of the air on passing through mist at 2000 feet high; that the two temperatures were together in the cloud, and then separated more and more, till at the extreme height there was almost a total absence of water.

August 21.

The results of this ascent, so far as temperature of the air and dew-point are concerned, are made evident to the eye in the third figure on Diagram IX. In this it will be seen that the decline of temperature in the first 5000 feet was more than 18°, and was not more than 10° from 10,000 to 15,000 feet.

September 5.

The results of this ascent are shown in the fourth figure on Diagram IX. The temperature of the air fell more than 20° in the first mile, and then declined less and less through each mile, till at the highest point it fell not more than 5° in a mile.

The temperature of the dew-point was the same as that of the air in the cloud, and they then departed from each other on leaving the cloud, and at the highest point were, as in the previous instances, separated by a large and unknown amount, implying, as before, a nearly total absence of water.

It was evident from the observations at these ascents that the variations both in temperature and humidity were either not determined at all, or were very imperfectly determined, in the lower strata of the air; and it became therefore desirable to have experiments made at low elevations only, the more particularly as the changes of temperature for equal increments of height were apparently very much smaller at the higher than at the lower strata of the air. Four ascents were therefore made at moderate elevations from the Crystal Palace; and one morning ascent to an intermediate height, from Mill Hill, near Hendon, the place where the balloon fell on the preceding evening, and where it had been anchored during the night. In these ascents a smaller number of instruments were used: they usually consisted of one or two barometers, one pair of dry- and wet-bulb thermometers, and one hygrometer.

The means of groups of observations are contained in the following Tables:—

July 30.

Time of		Groups.					
First Observation. P.M.	Last Observation. P.M.	No. of Observations.	Mean Height.	Mean Temperature.	Dew-point.	Differences between Air and Dew-point.	Degree of Humidity.
h. m. s.	h. m. s.		ft.	°	°	°	
4 36 0	4 40 0	2	250	68·1	49·8	18·3	51
4 40 30	4 42 30	7	520	65·8	47·0	18·8	50
4 43 0	4 44 30	3	1469	61·3	43·2	18·1	50
4 45 30	4 47 30	2	2416	56·3	42·2	14·1	59
4 48 30	4 50 30	4	3507	50·9	40·7	10·2	68
4 52 0	4 54 30	5	3860	51·2	39·9	11·3	66
4 56 0	5 4 30	11	4214	51·3	39·9	11·4	65
5 7 30	5 16 30	9	4813	48·5	37·4	11·1	66
5 17 30	5 24 0	7	5262	49·1	37·5	11·6	64
5 24 30	5 39 0	7	5622	46·7	36·2	10·5	68
5 40 30	5 44 0	4	6256	44·2	34·4	9·8	68
5 45 30	5 50 0	4	5714	45·5	35·5	10·0	68
5 52 0	......	1	6102	43·0	33·1	9·9	68
5 54 0	5 57 0	3	6620	46·6	34·4	12·2	63
5 57 30	6 1 0	6	6882	42·7	31·2	11·5	63
6 2 0	6 10 30	6	6629	44·5	31·1	13·4	60
6 11 30	6 13 0	2	6927	44·2	31·8	12·4	61
6 14 0	6 18 0	4	6611	45·0	32·1	12·9	62
6 18 30	......	1	6000	46·4	32·8	13·6	59
6 19 0	6 20 0	3	5650	46·4	35·3	11·1	66
6 21 0	6 22 0	2	4700	47·7	37·9	9·8	69
6 22 30	......	1	4160	49·0	38·6	10·4	67
6 23 0	6 24 0	2	3810	49·4	40·6	8·8	71
6 25 0	6 25 30	2	2700	56·9	41·9	15·0	58
6 30 0	......	1	on the ground.	68·0	47·4	20·6	47

August 20.

Times of		Groups.					
First Observation. P.M.	Last Observation. P.M.	No. of Observations.	Mean Height.	Mean Temperature.	Dew-point.	Differences between Air and Dew-point.	Degree of Humidity.
h. m. s.	h. m. s.		ft.	°	°	°	
6 5 0	6 27 0	3	250	66·6	56·2	10·4	69
6 28 30	6 30 0	6	563	64·6	53·5	11·1	68
6 31 0	......	1	1037	63·0	52·3	10·7	68
6 32 30	6 33 0	2	1447	61·5	51·5	10·0	69
6 34 0	......	1	1912	58·5	50·5	8·0	75
6 35 0	6 36 0	3	2275	56·5	49·4	7·1	77
6 37 0	6 37 30	3	2834	54·8	48·9	5·9	81
6 38 0	6 39 0	2	3259	52·9	48·5	4·4	85
6 41 0	6 41 30	2	3901	50·8	46·5	4·3	86
6 42 0	6 48 0	5	4274	50·5	44·8	5·7	81
6 49 0	6 49 30	2	4085	49·8	46·0	3·8	83
6 50 0	6 52 0	3	3726	51·5	44·9	6·6	78
6 55 0	6 56 0	2	3678	51·0	45·2	5·8	81
6 57 30	......	1	3743	50·3	45·2	5·1	77
6 58 0	7 2 0	4	3845	49·8	44·5	5·3	83
7 4 0	7 9 0	5	4263	49·6	44·8	4·8	87
7 10 0	......	1	3405	48·2	44·7	3·5	89
7 12 0	7 13 0	2	3544	50·4	44·1	6·3	79
7 15 0	7 16 0	2	2298	53·8	48·7	5·1	82
7 16 30	7 17 0	2	1763	55·1	49·4	5·7	81
7 18 0	7 19 10	3	1390	56·8	50·2	6·6	78
7 19 30	7 20 30	3	1287	57·4	51·2	6·2	81
7 22 0	......	1	1587	57·8	51·0	6·8	78
7 23 0	......	1	1667	57·2	51·4	5·8	82
7 24 0	......	1	1907	56·8	50·5	6·3	79
7 25 0	7 28 0	5	2193	56·5	50·3	6·2	79
7 29 30	7 30 0	2	2317	55·7	50·1	5·6	82
7 33 0	7 35 0	3	2723	54·5	49·0	5·5	81
7 35 0	7 36 0	2	2643	55·0	48·2	6·8	79
7 37 0	......	1	......	54·2	48·8	5·4	82
7 41 0	7 42 0	2	3351	52·1	45·3	6·8	78
7 47 0	7 48 0	2	5150	45·0	41·8	3·2	88
7 49 0	......	1	5900	43·0			
7 52 0	7 57 0	4	5160	43·6			

September 1.

Time of		Groups.					
First Observation. P.M.	Last Observation. P.M.	No. of Observations.	Mean Height.	Mean Temperature.	Dew-point.	Differences between Air and Dew-point.	Degree of Humidity.
h. m. s.	h. m. s.		ft.	°	°	°	
4 40 0	4 45 0	2	250	64·4	56·0	8·4	73
4 52 0	4 53 0	2	295	63·5	54·1	9·4	71
4 53 20	4 54 0	2	858	60·1	51·4	8·7	72
4 54 0	4 54 30	2	1600	56·2	49·5	6·7	78
4 55 0	4 59 0	4	2689	52·1	45·6	6·5	78
5 1 0	5 1 30	2	3125	50·0	42·8	7·2	77
5 3 0	5 4 0	2	3262	49·3	43·0	6·3	79
5 5 30	5 9 0	4	3564	49·5	38·8	10 7	68
5 10 0	5 11 30	3	3412	50·0	39·3	10·7	67
5 13 0	5 17 0	4	3640	49·1	38·4	10·7	67
5 19 0	5 20 0	2	3586	48·3	37·1	11·2	65
5 23 0	5 25 0	4	3972	47·1	37·1	10·0	68
5 26 0	5 29 0	5	3787	49·9	37·1	12·8	66
5 30 0	5 31 0	2	4045	47·2	36·3	10·9	66
5 32 0	5 35 0	3	4186	46·2	36·0	10·2	68
5 37 0	5 40 0	4	3498	47·6	38·3	9·3	70
5 43 0	5 45 0	3	2930	49·4	42·2	7·2	76
5 48 0	......	1	3170	48·2	40·4	7·8	74
5 50 0	......	1	2950	49·2	39 5	9·7	72
5 52 0	5 57 0	7	2355	50·7	45·8	4·9	83
5 58 0	5 58 10	2	1840	52·2	48·2	4·0	86
5 59 0	6 3 30	8	1541	54·5	48·5	6·0	80
6 4 0	......	1	2057	54·2	48·9	5·3	80
6 5 0	6 6 30	5	3099	53·7	49·2	4·5	83
6 8 0	6 9 0	3	2833	53·8	49·4	4·4	85

September 8.

4 47 0	......	1	250	67·2	61·2	6·0	77
4 48 0	......	1	813	66·5	60·4	6·1	81
4 49 0	4 50 30	3	1497	63·0	57·7	5·3	83
4 51 0	4 52 30	3	2625	58·5	53·7	4·8	84
4 53 0	4 54 0	2	3520	54·6	49·2	5·4	82
4 54 30	4 56 0	3	4369	51·5	49·0	2·5	92
4 57 0	4 59 0	6	4715	50·5	48·8	1·7	93
4 59 30	5 1 0	4	4540	49·5	47·1	2·4	91
5 2 0	5 5 0	5	3765	50·7	49·0	1·7	94
5 5 30	5 7 0	4	3325	52·8	50·0	2·8	91
5 7 30	5 10 0	2	3883	53·0	50·0	3·0	90
5 10 30	5 12 0	4	4327	51·4	44·7	6·7	80
5 12 15	5 15 0	5	4917	52·3	37·1	15·2	54
5 15 30	5 17 30	4	5174	56·5	35·5	21·0	46
5 18 30	......	1	5428	58·5	40·5	18·0	51
5 19 0	......	1	5388	60·0	40·3	19·7	48
5 20 30	5 24 30	8	5085	55·5	38·7	16·8	55
5 25 0	5 26 0	3	4532	51·2	47·3	3·9	86
5 26 20	5 28 0	4	3400	52·5	47·5	5·0	83

September 8 (*continued*).

Time of		Groups.					
First Observation. P.M.	Last Observation. P.M.	No. of Observations.	Mean Height.	Mean Temperature.	Dew-point.	Differences between Air and Dew-point.	Degree of Humidity.
h. m. s.	h. m. s.		ft.	°	°	°	
5 29 30	5 30 30	2	2868	54·7	47·8	6·9	83
5 31 0	5 31 45	3	2444	55·6	52·6	3·0	93
5 32 0	5 32 30	2	2148	56·2	54·1	2·1	93
5 33 0	......	1	1990	56·8	54·3	2·5	91
5 33 15	5 34 0	2	1736	57·2	55·0	2·2	92
5 35 0	5 37 0	4	1336	58·5	56·7	1·8	94
5 37 30	......	1	1077	59·8	56·5	3·3	89
5 38 30	......	1	932	60·0	59·6	0·4	98
5 39 0	5 39 15	2	823	60·3	59·0	1·3	96
5 39 30	5 40 0	2	775	60·7	59·6	1·1	96
5 40 30	5 41 0	2	849	61·3	60·8	0·5	98
5 42 0	5 44 0	3	887	61·1	59·9	1·2	96
5 44 30	5 47 0	5	834	61·4	58·7	2·7	91
5 48 0	5 49 0	3	890	61·3	58·7	2·6	92
5 49 10	5 50 30	3	846	61·1	58·7	2·4	92
5 51 0	5 52 0	2	727	61·3	58·6	2·7	91
5 54 0	5 54 45	3	553	61·8	59·0	2·8	93
5 55 0	......	1	895	62·2	59·0	3·2	90
5 55 10	6 0 0	9	1578	60·9	57·0	3·9	87
6 0 10	6 5 0	7	2098	59·7	54·6	5·1	86

By looking over the Tables, it will be at once seen that in no instance has the temperature of the air decreased uniformly with the height above the earth's surface—that in fact, the decrease of temperature in the first mile is more than double of that from three to four miles, and that the amount of decrease is intermediate between these extremes. The distribution of aqueous vapour in the air is no less remarkable. If the numbers in the Table be followed, it will be seen that the temperature of the dew-point decreases, on leaving the earth, less rapidly than the temperature of the air; so that the difference between the two temperatures becomes less and less, till the vapour-plane is reached, when they are usually together, and always most nearly approach each other (this elevation was about 5000 feet high); that, immediately after leaving the upper surface of the cloud, the dew-point decreased more rapidly than the temperature, and, in the extreme high stations, the difference between these two temperatures is wonderfully great, indicating an extraordinary degree of dryness and an almost entire absence of aqueous vapour.

Under these circumstances, the presence of cirrus clouds far above this dry region is very remarkable: on all occasions, when

seen, they appeared still as far above as when viewed from the earth. Of what can they be composed?

The change of 20° having been found in the first 5000 feet, it became desirable to know how this was distributed. Tables were accordingly formed showing the decrease of temperature for every increase of elevation of 100 feet up to 5000 feet; and the following are the results deduced from these Tables:—

When the sky was cloudy.

For the first 300 feet it was......					0°·5 for every 100 feet.		
From	300 feet	to	3400 feet	...	0·4	„	„
„	3400	„	5000 „	...	0·3	„	„

Therefore, in cloudy states of the sky, the temperature of the air decreases nearly uniformly with the height above the surface of the earth, nearly up to the cloud.

When the sky was partially cloudy.

In the first 100 feet there was a decline of						0°·9		
From	100 feet	to	300	„	„	0·8 for every 100 ft.		
„	300	„	500	„	„	0·7	„	„
„	500	„	900	„	„	0·6	„	„
„	900	„	1800	„	„	0·5	„	„
„	1800	„	2900	„	„	0·4	„	„
„	2900	„	5000	„	„	0·3	„	„

The decline of temperature near the earth, with a partially clear sky, is nearly double of that with a cloudy sky; at elevations above 4000 feet, the changes for 100 feet seem to be the same in both states of the sky.

In some cases, as on July 30, the decline of temperature in the first 100 feet was as large as 1°·1.

From these results we may conclude that, in a cloudy state of the sky, the decline of temperature is nearly uniform up to the cloud; that with a clear sky the greatest change is near the earth, being a decline of 1° in less than 100feet, gradually decreasing till it requires a space of 300 feet at the height of 5000 feet for a change of 1° of temperature. These results lead to the same conclusion as before, viz. that the theory of gradation of 1° of temperature for every 300 feet of elevation must be abandoned. As regards the law indicated by all these experiments, it is far more natural and consistent than that a uniform rate of decrease could be received as a physical law up even to moderate elevations.

XXIV. *Climate of Belize, British Honduras.*
By the Honourable S. Cockburn.

The month of August was hot and oppressive; September a little cooler; and now, October, it is fine and agreeable.

Belize has the character abroad of being *very unhealthy*; but I do not think it is *quite so bad* as is represented; still there are some peculiarities which have struck me, as a stranger recently arrived from a remarkably cool and healthy island, which do not seem to affect the people long accustomed to the climate. The most prominent of these is a thick, heavy, damp atmosphere, which is perceptibly *felt* by the stranger, keeps salt always in a state of deliquescence, and oxidizes every thing in the shape of iron or steel.

In the early morning a thick mist overhangs the town; and in the evening a heavy dew falls, and the stars are not *distinctly* visible in the clearest nights. What is considered here a *very bright* full moon appears dull and obscured to me, when compared with her appearance in the pure bright sky of the Antilles, where almost the smallest stars are visible to the naked eye.

On a calm day a dull heavy leaden cloud spreads over the heavens, obscuring the sun, the heat is oppressive and suffocating, and yet the thermometer falls. One *feels* as if it were at 85°, but on reference to the glass it is found to be only 80° or 82°. Whenever the easterly wind ceases, a slight westerly breeze sets in from the land, and brings with it a host of mosquitoes and sandflies, which swarm every corner of the house, causing great annoyance and discomfort, besides fevers, colds, and catarrhs from the miasma of the swamp behind the town.

I should have stated that Belize is built on a dead level along the shore in front of the sea facing the east, and that dank mangroves and festering swamps and decomposing vegetable matter surround the town on the other sides; so that were it not for the prevalence of the E. wind, which blows all the deleterious emanations into the back woods, the town would be very unhealthy indeed; but fortunately this easterly wind generally prevails, and brings health and freshness to the place. But even then the breeze does not seem to circulate freely; for the different rooms differ materially in temperature as they receive more or less of the breeze *direct*; and in those facing the E. one hardly feels the cooling influence, unless he stands in front of a door or window; the

moment he steps aside against the intervening wall, he feels as if there was no wind at all.

Upon the whole, however, the inhabitants seem to enjoy tolerable health, as is shown by the bills of mortality, and testified by many living to the age of 60 and 70. The yellow fever is *not* endemic; but it was *imported* here in 1859, when a great many persons, *natives* as well as Europeans, died. Even the *negro* lost his assigned immunity, and did not escape. It had not been known here for some twenty or thirty years before. Intermittents and rheumatism are the prevalent complaints.

XXV. *Sundry Meteors.* Ed. Gledhill; W. H. Wood; D. Walker; Alex. Falconer.

[Extracts.]

"On Sunday evening, February 2nd, 1862, at about 8.10 P.M., I observed a meteor, which illuminated the horizon from W. to E. like a flash of lightning, of a blue colour. It appeared to be travelling from W. to E. by N., and in an instant it exploded, and appeared to stand still for a moment where it burst; I observed no noise.

"I had not Greenwich time at the moment. It burst just under Orion, which was about due S. from where I stood."—Ed. Gledhill, *Halifax.*

"I was fortunate enough to observe a magnificent meteor last night, July 19th, 1862, at 11.17. It commenced as a dusky-yellow second-magnitude star from a star-cluster (Nos. 4, 5, 6) Camelopardi, and, in a long serpentine inclined course, gradually but slowly increased in size and brilliancy, and threw out a slender white tail of little permanence, 15° in length, until it arrived at stars 14 and 15 Leonis Minoris, when it rivalled Venus in splendour, and burst; projecting a shower of sparks in the direction of its line of motion, about 1½° in advance of the nucleus. The whole disappeared simultaneously. Time occupied in flight 4 seconds." —W. H. Wood, *Weston-super-Mare.*

"At 9.27 yesterday evening, September 1st, 1862, a very bright meteor shot for about 30° almost vertically (6.30 o'clock); centre

of its path passed close to η Herculis; at its appearance it was brighter than *twice* the size of Mars, gradually decreasing until it reached brightness of α Lyræ, when it burst; time $1\frac{3}{4}''$; exceedingly short tail."—D. Walker, *Seacombe.*

"On Thursday last, September 25th, 1862, between 6 and 7 P.M., say about half-past 6 P.M., Mr. Dent, of Barton Cliff, with whom I was walking, called my attention to a most magnificent meteor, the finest celestial phenomenon he ever beheld; and I was glad I had walked as far as his house, and thus saw this meteor.

"It came from the N., as though it suddenly issued out of the sky towards us, presenting a moon-like appearance, and vastly large and brilliant; it glanced off to the W., and disappeared, in the shape of a large brilliant ball of fire, the meteor issuing sparks (so it appeared), and a tail of light behind it like a comet. Its duration and appearance were hardly six or eight seconds of time; but being light at the time, there was no light seen on surrounding objects or on the ground around us. This one issued from the N.E. about 35° and vanished about 25° W.; it was the largest meteor, and the nearest I ever saw. The longest in duration and brightness, being at night, was one I saw on the top of the Edinbro' Mail Coach going to Kelso; it rose in the E. and made a course across the whole length of the horizon, leaving a trail of light, and burst in half like the two halves of an orange, and vanished low down in the W."—Alex. P. Falconer, *Beckton near Lymington.*

XXVI. *The Great Meteor of* 1862, *September* 19. By Ellis Hall; Alfred Batson; H. D'Urban; James Liddell; J. B. Tidewall.

[Extracts.]

"Last evening (Friday, September 19, at 10.15) I found myself instantaneously surrounded by a flood of light, almost equal to the midday sun, but of a very pale violet hue, and sufficiently brilliant to enable me to observe the minutest object. This lasted for several seconds; and on directing my attention to the portion of the heavens from which the light was thrown, an immense trail of light was visible, clearly showing the track of the meteor, and extending from a bright star of about the third magnitude in the Milky Way to the planet Mars. The direction of

the track appeared direct from west to east, quite horizontal, in a line a very little south of the zenith. The end of its path towards the west was of the same bright pale violet with the intense light by which I was at first surrounded. It would also appear that the explosion took place in this direction. In the other portion of its path the colour, changing gradually from pale red to vermilion and deep carmine, continued *in extenso* till gradually blended with the dark deep blue of the clear sky.

"The explosion must have taken place at an immense altitude and but very slightly removed from the zenith. I did not observe any sparks or coruscations, other than the long trail of light denoting its pathway. A slight semitransparent mist occupied the course it had taken; and the stars, which were very bright and clear at the time, were slightly obscured for several minutes after. The wind was blowing a gentle breeze from the north at the time." —Ellis Hall, *Enfield Highway.*

"My impression is that the explosion took place at rather less than half the distance traversed, and then it emitted a brilliant blue-white light, most intense; but it seemed as if in an hazy atmosphere of its own (query smoke?), as the nucleus of a comet is surrounded, but not as evidently so. The blueness of this light made the meteor itself and its train appear of a marked red. Of the body itself, I am not prepared to say much either as to form or size: to me it was *not* nearly the apparent diameter of the moon; the light from the explosion was, perhaps, as much as that of the full moon, and even appeared more so from its suddenness. I should estimate the time of the whole path about 1½ second. The train appeared gradually to diminish until it subsided in the nebulous appearance above-mentioned, in about 8 or 10 seconds.

"I agree with Mr. Slater that this nebulosity was the point of explosion, and was rather less than a degree across.

"At about 5 seconds from the commencement it had the aspect of a train across the nebulous appearance; it gave me the impression of being composed of a multitude of red points."—Alfred Batson, *Ramsbury, Wilts.*

"About half-past ten P.M. (Greenwich time) on Friday last, 19th September, 1862, the night being dark, but very calm and clear, and not a cloud in the sky, I was walking on the east bank of the Exeter Canal, when I was startled by a bright streak of rosy light thrown across the path, and, on looking round, I saw what I at first

thought was a sky-rocket. It described a downward curve like that of a shell, fired at a moderate elevation, at the end of its flight. It almost instantly burst, with a yellow flame, when I perceived it was a meteor of unusual magnitude. A streak of light of a deep red colour remained visible in its path for a few seconds. I saw no blue colour whatever. It moved in a course a little east of north, slightly slanting across the River Exe, and parallel to me as I walked along the canal bank. A friend who saw it from Pennsylvania, about four miles to the north of where I was, says it appeared to him in the south. I therefore imagine it had no great elevation when it burst. The meteor exactly resembled a bursting shell."—H. D'Urban, *Newport, near Exeter.*

"I happened to be walking to our lodging here at 10.10 P.M., September 19, 1862, when a sudden blaze of light illumined the road and surrounding objects; and my wife, who had my arm, trembled violently, supposing it to be a vivid flash of lightning. We were walking west; and on turning rapidly round, I observed the brilliant meteor passing from the Pleiades towards the northern horizon at an angle of 45°. It left behind a dazzling track of sparks like a rocket, and burst about 5° above the horizon. I fancy the meteor must have been about 200 miles nearer to you than to us, judging roughly from the description given of it by an observer in London.

"The night was very fine and cloudless, and I have never but two or three times had the gratification of witnessing so brilliant a meteor."—James Liddell, *St. Colomb, Cornwall.*

"The large meteor noticed in 'The Times' of Saturday by Mr. Edmunds and Slater, was seen here on Friday evening, September 19, 1862, by some of the servants. They represent it as very bright, and resembling a fine rocket, and of a blue colour. Its direction north-east, and visible but for one or two seconds."—J. B. Tidewall, *The Castle, Bude Haven, Cornwall.*

BOOKS AND NOTICES.

XIV. *De la Prédiction du Temps*, par M. MATHIEU (DE LA DROME). Deuxième Edition, 1862, 8vo. pp. 58.

M. MATHIEU (de la Drome), formerly Member of the French Chamber of Deputies, has published a pamphlet, in which he claims to have discovered what has been so long desired, and so often attempted without result—a system of predicting rainy periods and seasons; and with the most perfect confidence he asks for the strictest examination of the data on which his conclusions are founded.

Some time in the year 1855, M. Mathieu, though disbelieving in lunar influence, entertained the idea that all the aqueous meteors with which our atmosphere is visited or affected obey laws as fixed and immutable as those which regulate the movements of the planets. With the view, therefore, of ascertaining these laws, he commenced an investigation which resulted in the admission that what he had previously considered mere popular prejudice is perfectly philosophical. He is now convinced that whilst the sun plays the principal part in raising vapours, it is the moon that determines their precipitation and distribution; and he believes that this is effected by the agency of atmospheric tides, and the changes of the wind consequent thereon.

Avoiding the methods usually adopted, which he considers necessarily produce negative results, M. Mathieu was led to examine the relation which exists between the moon's phases and the four cardinal positions of the sun, viz., whether the changes occur whilst that luminary is in the upper or lower meridian, and whether near the rising or setting. He then, it appears, extracted, from the meteorological register kept by Saussure at Geneva*, the observations of rain for the several days of the lunation, and arranged them in categories according to the time of day and season of the year when the change occurred. The difference in the quantity of rainfall thus elicited is very considerable; and though the number of observations is not large, it should be remembered that they are spread over an extended series of years; and the results appear to be remarkably uniform.

For example, in the case of the new moon in the months of September, October, November, and December, if that phase occurred between the hours of 8 A.M. and 9.30 A.M., the amount of rain greatly exceeded the quantity registered when the new moon arrived between 7 A.M. and 8 A.M. During sixty years there were seventeen instances of its occurrence between 8 and 9·30 A.M., and fifteen instances between 7 and 8 A.M.

The 17 instances gave 532 mm. rain.
The 15 instances gave 266 mm. rain.

* From 1796 to 1856.

M. Mathieu supplies the dates and quantities of the maximum rain-fall in both categories—each sum including the amount of rain for the day of the change and the several days following, up to the day of the next quarter.

The following is the Table of maxima alluded to:—

1st Category, between 8 and 9.30 A.M.	A.M.	mm.	2nd Category, between 7 and 8 A.M.	A.M.	mm.
1840. 25 Oct...N.M.	9.7	112 rain.	1833. 13 Oct....N.M.	7.2	77 rain.
1799. 28 Sept. N.M.	8.13	73 rain.	1810. 26 Dec...N.M.	7.18	26 rain.
1828. 9 Sept. N.M.	8.43	65 rain.	1833. 11 Déc...N.M.	7.15	23 rain.
1802. 25 Nov. N.M.	8.4	52 rain.	1846. 20 Oct....N.M.	7.53	21 rain.
1838. 17 Nov. N.M.	8.11	42 rain.	1807. 2 Sept. N.M.	7.14	20 rain.
1831. 6 Sept. N.M.	8.42	29 rain.	1808. 20 Sept. N.M.	7.56	19 rain.
1824. 22 Oct...N.M.	8.13	21 rain.	1843. 23 Oct....N.M.	7.45	19 rain.
1839. 6 Nov. N.M.	8.21	19 rain.	1809. 9 Oct....N.M.	7.51	8 rain.
1853. 1 Nov. N.M.	8.48	14 rain.	1820. 7 Oct....N.M.	7.22	5 rain.
Total sum		427 mm.	Total sum		218 mm.

Deducting the sums 427 and 218 from the sums 532 and 266, the ratio between the remaining examples of rain-fall (eight in the first category and six in the second) is $2\frac{1}{5}$: 1.

M. Mathieu, after giving other examples at new moon, passes on to the first quarter, which he finds of the four phases is the one "which gives or transmits the most rain," thereby confirming the results obtained by Schubler, Arago and others, and strengthening the position advanced in a former Number of the 'Proceedings,'* that the *heat* which is found, on an average of several lunations, to display itself at the period of first quarter is due to the existence of cloud and rain.

Two Tables are given of the amount of rain which was registered, in June, July, and August in the 60 years, at first quarter.

From these Tables it appears that the first quarters which arrived between 11.30 A.M. and 3 P.M. brought more rain than those which occurred between 10 P.M. and 1 A.M. There were twenty instances of the former, and twenty-three instances of the latter time of the change.

The 20 instances gave 509 mm. rain.
The 23 instances gave 336 mm. rain.

The means of the two being $25\frac{9}{20}$ and $14\frac{14}{23}$.

In the case of the twenty-three instances which occurred between 10 P.M. and 1 A.M., nearly the whole rain-fall was registered in quarters where the phase arrived between *ten and eleven* o'clock P.M.

Again, the first quarters which occurred in the month of July and August between 4 A.M. and 5.30 A.M., were found to bring more rain than those which arrived between 6 A.M. and 8 A.M. There were nine instances of the first hour of the change, and fifteen instances of the second.

* No. 2, p. 108.

The 9 instances gave 301 mm. rain.
The 15 instances gave 108 mm. rain.

The means are 33$\frac{4}{9}$ and 7$\frac{1}{5}$.

M. Mathieu observes that if the nine instances between 4 A.M. and 5.30 A.M. had been compared with six instances which occurred between 7.30 A.M. and 7.55 A.M., the ratio of the mean difference would have been 33$\frac{4}{9}$: 0$\frac{1}{6}$.

Encouraged by these results, and tempted by the numerous coincidences and indications of system which have led many, from Toaldo downwards, to believe it possible to fortell the weather by the aid of our satellite, M. Mathieu enters into a further analysis, from which new combinations of hours and phases are obtained, by means of which he believes *rainy* periods may be predicted. Into these questions it is not possible, from the complicated nature of the system, to enter, with fairness to the author, unless the whole of this portion of the pamphlet were transcribed. As regards the connexion, however, which M. Mathieu traces between different phases, it may be mentioned that many examples of the recurrence of maximum and minimum *temperatures* on corresponding days of different quarters in the same and successive lunations were cited in a paper on the Moon's Influence, in the Brit. Assoc. Report for 1859. Though not aware apparently of this parallel investigation, M. Mathieu expresses a strong conviction that the temperature of the air depends, as a necessary consequence, on the presence or absence of rain and vapour.

It is well to notice that M. Mathieu's theory deals strictly with *aqueous meteors*, and not with the weather of any particular day.

SUNDRY NOTES.

4. *Mr. Glaisher's Balloon Trips.*—Poetry has described some famous *descents*; and the *facilis descensus Averni* comes back with a familiar school-twang to us. These dips into the subterranean world do not, indeed, belong to the region of historical truth, nor do they even profess to have been made for scientific purposes, yet, perhaps, they symbolize a certain spirit of discovery appropriate to those ages. The two chief adventurers into those parts, the two epic heroes, were great travellers—the explorers of their day. Science has just now, however, surpassed all the fancy of poets. We have just had an *ascent* such as the world has never heard of or dreamed of. Two men have been nearer by some miles to the moon and stars than all the race of man before them. It is true they do not bring back a very glowing report of their approach to the region of the empyrean; yet their voyage upwards is not without poetical features. On reaching the clouds they find themselves among strange phenomena. They cut through a

dense mass of moisture 2000 feet in thickness, after which the scene changes, they are received out of the thick fog into the clear blue vault of a liquid sky, and see the landscape of clouds beneath them. Mr. Glaisher attempts a photograph of the beautiful scene; but the rapidity of the flight defeats the process, and as the car mounts upwards the paper refuses to receive the constantly vanishing impression from below. They now reach a fearful altitude, where pigeons—the unhappy victims of all experiments—cannot fly, and where, at last, the rarity of the air is too great for the physical structure of man, and one of the explorers faints and becomes unconscious. Yet such is the determination of men when they are in the act of experimentalizing, and at the very climax of their feat, that they will not spoil it by a check so long as progress is possible; on they will go, and grudge forestalling their vertex by a foot, for every foot is so much gain and so much triumph. For ten whole minutes Mr. Coxwell ascended alone—or rather worse than alone, with his companion insensible before his eyes, in a region six miles distant from the earth. That is a very extraordinary ten minutes, if we think of it—that solitary command, without a rival, of the boundless regions of space, when, for once, to be "alone in the world" was not a metaphor, and one head was working in the infinite void. It deserves to take its place among the unparalleled junctures and the critical and striking moments of war, politics, or discovery. But the feat was almost too audacious, and was carried on to the very verge of fate. Mr. Coxwell was only just in time to take the step which was necessary for a return to the lower world; another minute and he would have been stretched by the side of his companion, and a car containing two human bodies would have been mounting to worlds unknown, and encountering aërial storms and shipwrecks so removed from all our sublunary experience that we can hardly form the faintest image of the reality. We know enough of the geography of the heavens to know that it would not have been even dashed upon the bleak shore of a planet, or found a resting-place upon some Ararat in the moon. But Mr. Coxwell's mouth performed the task which his paralysed hands were unequal to; and the release of the gas procured a descent, and gave a safe termination to the most audacious aërial feat ever performed.

The courage of men of science deserves to have a chapter of history devoted to it. It has been observed that courage is a very capricious and inconsistent virtue; and we all of us know the old anecdote of the gallant veteran of a hundred battles who durst not snuff out a candle with his fingers. Courage is a thing of habit, and sometimes it fails altogether immediately it is out of the field of its habit. Your bold rider is one who has begun young, and become a sort of Centaur, only with the convenience of dropping off the animal part of his figure when he chooses; his whole body, with its muscles and sinews, has accommodated itself to the back of a horse, and acquired an intuitive and unconscious balance. But take him off his horse, and, unless he has the *principle* of courage within him, he is an ordinary mortal, and no more likes

breaking his neck than a quiet humdrum citizen. A soldier is accustomed to courage in company, with gallant fellows around him; but that makes an immense difference. Company is both inspiring and relieving; it divests courage of its horrors and gloom. It is therefore much easier to be bold in company. But send your bristling warrior a nocturnal walk along a lane, and he sees ghosts peeping from behind haystacks, and hears supernatural voices in every gust of air. The feats of a man of science give you a better guarantee for real courage, because they are solitary, deliberate, calm, and passive. It is true he has his enthusiasm which helps him, and he has his field of courage to which he has accustomed himself. But every new venture, every fresh essay upon this field, is a solitary effort and impulse with him. He has to fight alone and by himself against the faintness of nature, without men shouting, or flags flying, or trumpets clanging around him. He faces the invisible forces of nature, the gas that explodes or the poison that penetrates, with the countenance of a student and philosopher, and is at the disadvantage of having to be fully conscious and self-possessed, instead of having the aid of the swing and impetus of passion. The cool feats of our scientific men are known to us all—such as that of Sir Humphry Davy inhaling a particular gas, with an accurate report every minute or two of its successive effects upon his brain and senses. The aërial voyage just performed by Mr. Coxwell and Mr. Glaisher deserves to rank with the greatest feats of our experimentalizers, discoverers, and travellers. It is true these gentlemen have not brought down a very comfortable or inspiring report of the upper world into which they have penetrated. Science and poetry are unhappily rather at variance upon the subject of the air and the sky. Poetry points upward to the sky with glowing rapture as the scene of brightness and glory, and a residence there figures as the reward of heroism and greatness. Everything is happy and splendid that is connected with the sky. But science penetrates with its material eye into these vast upper spaces, and simply reports a great difficulty of breathing there, that the blood stagnates, the limbs become benumbed, the senses evaporate, and nature faints in unconsciousness. The very birds will not fly in that very sky which is their poetical home. The distinction is that poetry looks up to the sky from below, and science examines and feels it on a level. The sky is the emblem of poetry, the fact of science. Both aspects of it are equally true, but the point of view from which they are taken is quite different. But, though our recent explorers of the sky do not add to its brilliancy as a picture, they have furnished one more striking and impressive scene to the history of science. They have shown what enthusiasm science can inspire and what courage it can give. If the man, as the poet says, had need of "triple steel about his breast" who first launched a boat into the sea, certainly those had no less need of it who first floated in the air six miles above the surface of the earth. —*From the Times*, 1862, September 11.

5. *On the Nocturnal Cooling of the superficial section of the ground, compared with that of the stratum of air in contact with the earth.*—"There is one point upon which I regret to find myself differing from M. Marcet. I have said that in the night the temperature of the surface of the ground was higher than that of the stratum of air in contact with it. M. Marcet affirms the contrary. The difference is more apparent than real. By surface of the ground, I do not understand the mathematical surface, or plane of separation of the air and the ground; but rather the most superficial section of the ground, the thickness of which is little more than the diameter of the thermometers employed in my experiments: this section was 2 cm. (0·78 inch) thick, the diameter of the bulbs of my thermometers being 0·015 m. (0·59 inch). It is the temperature of this superficial section of the ground that I desired to know, because it is interesting in vegetable physiology. Besides, I do not think it would be possible in the present state of physics to measure the temperature of the surface itself of the ground. In fact, when M. Marcet lays a thermometer upon the ground, this thermometer does not touch the ground except by a small portion of its surface; the major portion of the surface is surrounded by air. This thermometer therefore gives, and can only give, a kind of mean between the temperature of the lowest stratum of air and the surface of the ground. In this mean it is the temperature of the air that dominates, because it is in fact the air which impinges upon the larger surface of the thermometric bulb. The thermometers with a lenticular bulb that I have seen at M. Walferdin's would indicate a more approximate mean between the air and the surface of the ground. In fact, with one of their faces they would be in contact with the ground, whilst the other would be surrounded by the air. M. Marcet's thermometer, the reservoir of which was spherical (for he gives it the name of ball), indicated, on the contrary, when it was laid upon the ground, a temperature differing but little from that of the air in contact with the surface of the ground: now, according to his experiments and mine, this stratum of air is colder than all those which are superposed over it. Calling this temperature *the temperature of the surface of the ground*, M. Marcet ought to find it almost always lower than that of the air which is 5 cm. (2 inches) above.

"To put these facts beyond doubt, I this winter renewed my experiments in the Jardin des Plantes of Montpellier ....

"The results are in accordance with those that I had previously obtained. The most superficial section of the ground is *warmer* than the air with which it is found in contact. The thermometer laid upon the surface of the ground indicates a lower temperature than that of the ground, but sensibly equal to that of a free thermometer at 5 cm. (2 inches) above; the difference is only 0°·04.

"M. Marcet suspects that the higher temperature of my thermometer in the ground was due to the slight coating of earth which covered it, and which would have diminished its nocturnal radiation. To learn whether this was really the fact, I placed

three minimum-thermometers upon little forks. The bulb was raised 2 inches above the surface of the ground; but that of the first was naked, that of the second covered with a slight layer of garden-mould, the bulb of the third was coated with soot, which, as well as the mould, I made to adhere by means of a coat of gum.

"The following are the minima of seven perfectly serene nights of the month of March 1862:—

Naked thermometer	4°·25
Thermometer covered with soot	4°·28
Thermometer covered with mould	4°·34

"The three thermometers, as we see, indicate sensibly the same temperature......

"I think therefore that I have established experimentally the following facts:—

"1st. During the night, the superficial section of the ground is cooled less than the stratum of air that is in contact with it.

"2nd. The emission of heat from the superficial section heats bodies that are placed at a small height above it."—CH. MARTINS. *Bibl. Univ. Arch. des Sc. Phys.* No. 55, 20 July, 1862, pp. 250–255.

"Having received a communication from M. Martins of the preceding notice, I will confine myself to remarking that the interesting observations which it contains in no way impugn the results that I have obtained, and that the contradiction between us, as indeed he has himself taken the opportunity of remarking, is more apparent than real; I may even venture to say that in substance we perfectly agree. Indeed, what I have stated is that the temperature of the surface of the ground, properly so called, as far as it is possible to determine it in a tolerably approximate manner, *must be* and *is* actually lower than the temperature of the air at two inches above this surface; but I have never pretended to deny (and my experiments prove it) that, if a comparison is made between the temperature of the interior of the superficial section of the ground, by inserting into the latter the bulb of a thermometer to the depth of one or two cm. (half an inch or so), and that of the stratum of air immediately above, the temperature of this stratum of air might be lower than that of the superficial section of the ground."—F. MARCET. *Ibid.* p. 256.

ITS DIFFERENT ELEVATIONS.

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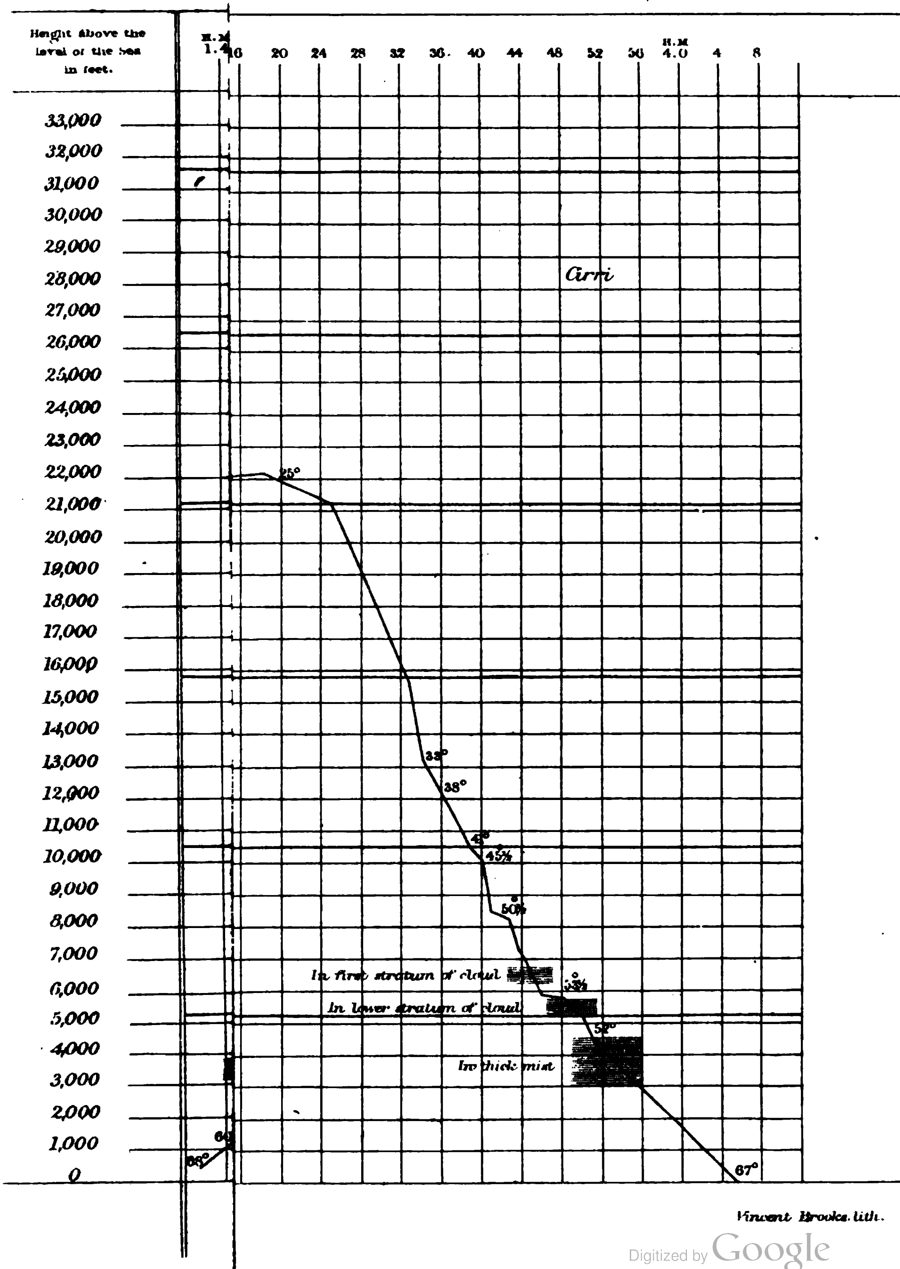

Vincent Brooks. lith.

DIAGRAM

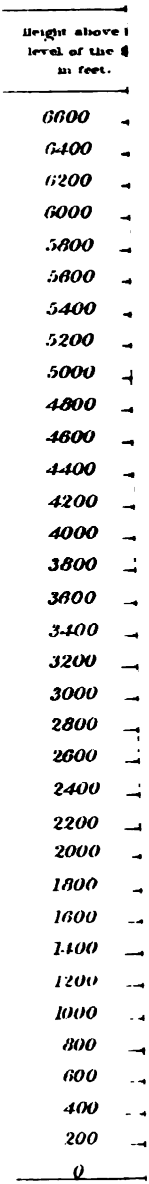
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Plate IX

F THE AIR AT ITS DIFFERENT ELEVATIONS.

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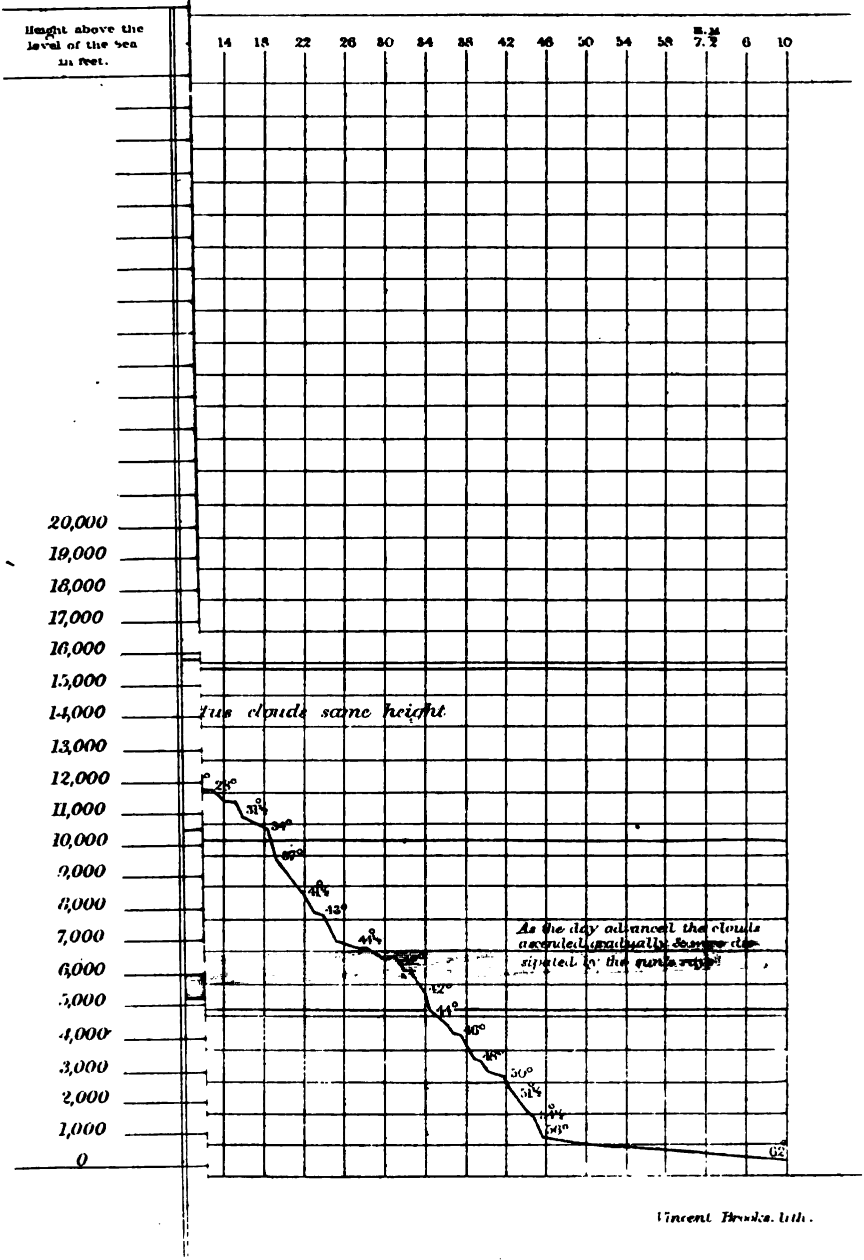

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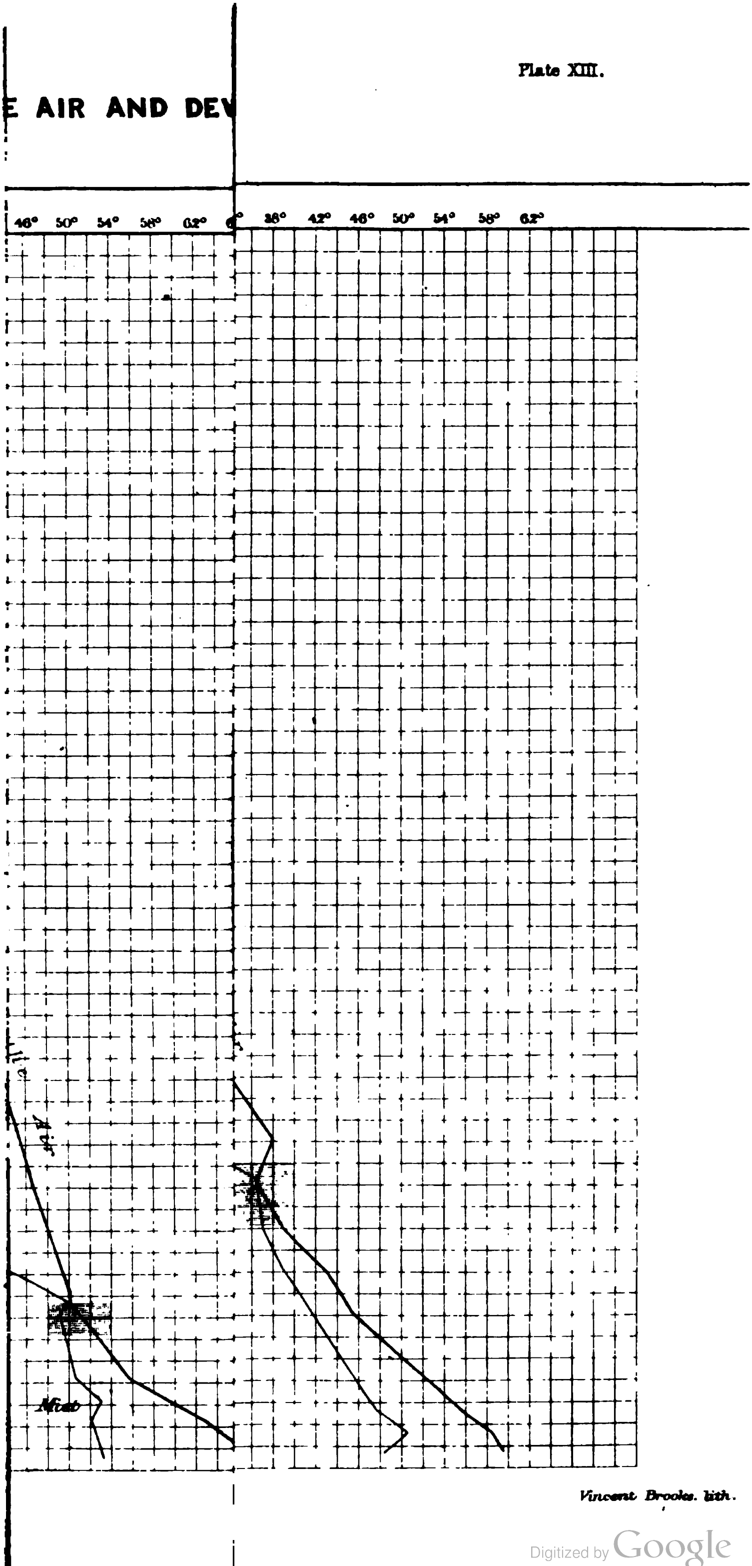
Plate XIII.



Vincent Brooks. lith.

[*Price Two Shillings.*]

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BRITISH METEOROLOGICAL SOCIETY.

THIS Society was established in the year 1850, for the encouragement and promotion of Meteorological Science.

It consists of Members and Honorary Members.

Every person desirous of admission into the Society must be recommended by at least Three Members, of whom one must certify to his personal knowledge of such Candidate.

Candidates may be proposed at a Council Meeting; but the ballot must take place at an Ordinary Meeting. One Council or Ordinary Meeting must intervene between the nomination and the day of Election.

There is no Admission Fee. The Annual Contribution is £1; due on January 1. The Composition Fee is £10.

Persons eminent in Meteorological Science, not permanently residing in this country, are eligible as Honorary Members.

The Council of the Institution of Civil Engineers allow the Society to hold their Meetings at the Institution, No. 25 Great George Street, Westminster, S.W.; and to receive letters there.

Four Ordinary Meetings are held during the Session, which commences in October and terminates in June, at which Members can introduce their friends.

Papers accepted for reading at the Ordinary Meetings are published entire or in Abstract in the 'Proceedings' of the Society, which are issued as soon as possible after each Meeting, *and of which a copy is sent to every Member of the Society.* The 'Proceedings' also contain Notices of Books and Memoirs, descriptions of New Instruments, and other Meteorological News.

Daily observations are made, for the most part by Members of the Society, at about 60 different stations, which are forwarded monthly to one of the Secretaries, by whom each reading is examined and collated with readings made in adjacent stations. Their means are taken; and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of each 'Quarterly Meteorological Report' *is sent free to every Member of the Society.*

Copies of printed results of Meteorological Observations or Papers are from time to time received by the Society for distribution; and *are forwarded free to Members.*

The 'Proceedings' of the Society are published and sold by Taylor and Francis, Red Lion Court, Fleet Street, E.C.

The Society possess a Library, which is available to Members. The President, N. Beardmore, Esq., has kindly received it in his rooms, 30 Great George Street.

The address of the Treasurer, H. Perigal, Esq., to whom subscriptions may be paid, is 57 Warren Street, Fitzroy Square, W.

1863, January 1.

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CHARLES V. WALKER, F.R.S.,
Fernside, Redhill.
} *Secretaries.*

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

VOL. I.] 1863, JANUARY 21. [No. 6.

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were balloted for and duly elected Members of the Society.

XXVII. *Average Height of the Barometer in London for* 83 *Years.* By HENRY STORKS EATON, Esq., M.A., Librarian.

EQUALLY interesting in a meteorological point of view with that of temperature (which, from its more manifest effects, first attracts

our notice) is the subject of atmospheric pressure, though till of late years the question has hardly received the attention it deserves. The bad construction of the instruments in former times, and the want of suitable Tables to reduce the observations, contributed chiefly to this deficiency. At the present day, however, comprehensive Tables for the reduction of barometrical observations are in general use; and instruments nearly perfect in their construction, or whose index-errors are known, may be obtained by any one.

As far as I am aware, no careful determination of the average height of the barometer in Great Britain has been published which embraces a period of any considerable length of time. Tables have, indeed, been put forth by Dalton, Howard, and others, yet always with some reservation throwing doubt on their accuracy; they cannot, therefore, be accepted with confidence.

To supply this deficiency, so far as London is concerned, I have been induced to undertake the reduction of the series of observations made at Somerset House, under the auspices of the Royal Society, and to combine them with those subsequently taken at the Royal Observatory, Greenwich. In this way we obtain a series of 83 years of observations.

By reducing these still further to sea-level, we are at once put in a position to form a judgment of the monthly and annual height of the barometer, and the fluctuations to which it is liable. The complete reduction of the observations, easy enough in appearance, yet proved on trial a matter of much difficulty, involving a great amount of labour. As I venture to hope that the results here stated may be accepted as correct, it becomes necessary to give a detailed description of the register, the instruments employed, and the method of reduction.

Period embraced in the Register.—The Register at Somerset House commences with the year 1774: it was omitted from September 1781 to December 1786, but from this time till June 1843 was continued without interruption, save for a short break during part of March and April 1826.

The Royal Observatory Register commences with December 1840, and is still continued.

In the reduction of the monthly averages to mean sea-level, the Royal Society's Register is employed up to the end of 1842; and from that date the Greenwich records are used.

Hours of Observation.—Previous to 1823, the usual hours for observation at Somerset House were 8 A.M. in the months of

December, January, and February, and 7 A.M. during the rest of the year. A second observation was made at 2 P.M. From 1823, the hours were 9 A.M. and 3 P.M. The occasional slight variations from these hours have not been taken into account in reducing the observations.

At Greenwich, up to the close of 1847, observations were taken at every even hour, Göttingen mean time, except on Sundays and holidays, when they were altogether omitted.

Since 1847 the hours of observation have been 9 A.M., noon, 3 P.M., 6 P.M., and 9 P.M., Greenwich mean time on every day.

Instruments employed.—The instrument used till the end of the year 1822 is described by the Hon. H. Cavendish, by whom it was erected (see 'Philosophical Transactions' for 1776, pp. 371–74).

It was of the cistern kind; and the height of the quicksilver was estimated by the top of its convex surface. The inside diameter of the tube was about 0·25 of an inch. The capacity of the cistern, when compared with that of the tube, was as 120 to 1; and the fiducial point about 29·75 inches.

As the tube appeared to be well filled, it was not thought necessary to have the quicksilver boiled in it. In the latter part of 1824, Professor Daniell, of King's College, found, on a mean of 20 observations, that this instrument read about 0·07 in. lower than his then recently erected standard, and that the mercury in the tube was thickly studded with air-bubbles.

From 1823 to 1836, a barometer by Daniell was observed. It is described by him in his 'Meteorological Essays and Observations,' London, 1823, pp. 353–57. The internal diameter of the bore of the tube was 0·53 in.; the cistern was of well-seasoned mahogany, and its capacity to that of the tube as 100 to 1. The fiducial point of the instrument was 30·576 inches. The specific gravity of the mercury used in filling the tube was ascertained by Faraday to be 13·624, the metal and the water both being at a temperature of 40°; and the mercury was boiled in the tube. Finally, the scale was measured off by a brass dividing-engine that had belonged to Cavendish.

The barometer by which this was replaced in 1837 has been fully described by Francis Baily in the 'Philosophical Transactions' for 1837, pp. 431–32. The scale was engraved on a brass rod, tipped with agate at the lower extremity, which at each reading was brought into contact with the mercury in the cistern; there is therefore no correction for capacity. The barometer was fitted with two tubes, one of crown, the other of flint glass; the latter had an

internal diameter of 0·594 in.; and the indications of this instrument have been accepted in preparing the latter part of Table V., inasmuch as of late years it has been generally received as the standard, to which all others have been referred. Dr. Prout ascertained the specific gravity of the constituent mercury to be 13·581, the thermometer being at 62°, and the barometer at 30 inches.

The barometer at Greenwich is a standard by Newman; the scale is of brass, tipped at its lower end with a conical point of ivory, which point is made to touch the mercury in the cistern at each observation. The internal diameter of the tube is 0·565 of an inch.

It may not, perhaps, be amiss to remark here, that the Greenwich barometer reads +0·001 in. higher than the Royal Society's standard; and that +0·003 in. was added for capillarity to the Royal Society's standard by Mr. Baily. The correction applied to the Greenwich barometer for capillary action is +0·002 in.

Method of keeping the Register.—After each observation, at the commencement of the series, the readings of the barometer to the hundredth part of an inch, and of the attached thermometer, were entered in the register; and no correction was applied to the simple readings. At the close of each year, a Table of averages was drawn up. In 1823 this laudable custom was discontinued, and the system of applying partial corrections to the actual readings was introduced and continued in force till 1837, when the original method was restored; but, as will be shown hereafter, many of these so-called corrections were themselves erroneous. The readings of the barometer were observed to the thousandth part of an inch from 1837. At the Royal Observatory, the indications of the instruments are corrected, at the time of observation, for temperature, capillarity, and diurnal range, the latter correction having been applied since 1847.

Condition of the Register at Somerset House.—It is a matter much to be regretted, that great carelessness is evident on the face of the register, entailing numerous errors. These are of two orders—errors of observation and errors in the calculation of the monthly averages. Up to about the year 1789, the former source of error was comparatively rare, and chiefly confined to mistakes of an inch in the entry, while instances of miscalculation of the average are of frequent occurrence. From 1790 to about 1806 the register has been carefully kept and the errors are few; but the record of the succeeding years to June 1827 was of such a character as to call forth the severe animadversions of Dalton, Howard,

and Daniell. From that date scrupulous attention was paid to the accuracy of observation and calculation of the means.

Since it is evident that but little value can be attached to the register, as given in the 'Philosophical Transactions,' I have thoroughly revised the whole of the observations, collating them with contemporaneous registers kept by the Horticultural Society at Chiswick, and by Howard at Tottenham, Stratford, and Plaistow. I have also recalculated all the monthly means up to the year 1827, allowance being made for occasional deficiencies in the daily observations.

It appears from this examination that, from the above-mentioned sources alone, there are no fewer than 128 instances in which the recorded monthly averages differ from the truth by 0·01 in. and more; the errors sometimes even exceed 0·50 in. In the Tables of monthly averages (Tables IV. and V.), these are indicated by an asterisk.

Method of reduction.—After the errors of registration had been, as far as possible, eliminated, instrumental errors became the next subject of inquiry.

In Cavendish's barometer, whose neutral point was 29·75 inches and capacity 120, the corrections which have been applied for capacity are, when the barometer was

	inches.		inches.	inch.
Between	30·41	and	30·29	+ 0·005
„	30·29	„	30·17	+ 0·004
„	30·17	„	30·05	+ 0·003
„	30·05	„	29·93	+ 0·002
„	29·93	„	29·81	+ 0·001
„	29·81	„	29·69	0·000
„	29·69	„	29·57	− 0·001
„	29·57	„	29·45	− 0·002
„	29·45	„	29·33	− 0·003

The next step was to reduce the observations to freezing-point; this was accomplished by Tables calculated from Schumacher's formula—

$$h.\frac{m(t-32^\circ)-l(t-62^\circ)}{1+m(t-32)},$$

en h = the observed height of the barometer in inches;

t = temperature of attached thermometer in degrees of Fahrenheit.

m = expansion, in volume, of mercury for one degree Fahrenheit =0·0001001.

l = linear expansion of scale for one degree Fahrenheit =0·0000104344, the normal temperature of standard being 62°.

The assumed value of l, in the above formula, is that due to brass; and as the scales of the two earlier barometers were of wood, the corrections may not be strictly accurate, though the difference is so small that it may be safely neglected.

The effect of moisture in the air on these instruments is very uncertain, and quite beyond the range of calculation.

As the internal diameter of the tube was 0·25 in., and the mercury appears not to have been boiled in it, the correction for capillarity due to tubes of that diameter, viz. +0·040 in., was then added.

Finally a correction of +0·030 in. for index-error was applied to all the observations from 1787. This may seem a hazardous proceeding, and I have adopted it only after careful consideration, and for this reason; Professor Daniell found, at the close of 1824, that this barometer stood, on an average of twenty readings, 0·07 inch lower than his recently erected standard; of this difference, we have seen that 0·040 in. is due to capillarity: the remainder must therefore be index-error. Now a question arises, as to whether this must be ascribed to an original imperfection in the instrument, or to its gradual deterioration. Daniell himself inclines to the latter opinion, for reasons he has stated in an essay "On the Gradual Deterioration of Barometers, and the means of preventing the same." The element of uncertainty thus introduced is sufficiently perplexing; but, fortunately, it affects the absolute rather than the comparative value.

As the most effectual way of meeting the evil, I have applied the correction +0·030 in. to all the monthly values from 1787 to 1823, leaving untouched the series from 1774 to 1781. It may be briefly mentioned that, towards the close of 1824, when the comparisons between Daniell's and Cavendish's barometer were made, the mercury in the former instrument stood half an inch or more below the neutral point; and that the negative correction, arising from this circumstance, is pretty evenly balanced by the positive correction required for capillary action; while, in Cavendish's barometer, the mercury standing about the neutral point, the correction for capillarity applied in full force.

With the commencement of 1823, Daniell's barometer was

brought into use. The observations were corrected for capacity and capillarity at the time of entry in the journal. The capacity-correction is +0·001 in. for every tenth of an inch below 30·576 inches; and +0·006 in. was added as the correction for capillary action; this is about +0·003 in. too high, but I have not altered it. Corrections were subsequently applied to the mean of the month to reduce the readings to what they would have been at 32°; but, from a change of plan in graduating the instrument, the Table of corrections for temperature drawn up by Daniell was not applicable, notwithstanding which it was used.

The mistake arose in this way: it had been originally proposed to cut the scale of the instrument on the glass tube itself, and in accordance with this idea the Table had been calculated for the mean expansion of mercury and dilatation of glass; however the plan was abandoned, and the scale, engraved on a piece of brass 4 or 5 inches long, was let into the wooden framework which supported the instrument. According to this Table, when the attached thermometer was at 70° and the barometer at 30 inches, the correction applied was —0·098 in., the true correction being —0·114 in.; when at 85°, they both become —0·006 in.; besides this, after 1827, all the corrections were applied on the assumption that the barometer stood uniformly at 30 inches. I have therefore applied equations to all the monthly means of the barometer between 1823 and 1836, in order to get rid of this error. The average of the corrections in July is —0·017 in., and in January —0·004 in. It remains to be added that the indications of the attached thermometer were not published from January 1823 to April 1826, and I have been obliged to estimate the value; and that, from April 1826 to the end of the year, the barometer had been corrected for temperature from the indications of the external thermometer, for which allowance has also been made.

In 1837, the astronomer Francis Baily inaugurated the system of exact observation and reduction, which has continued up to the present day. He personally superintended the erection of the standard barometer, the observations of which were recorded till the series at Somerset House closed in 1843.

Of the corrections applied to the Greenwich barometer, the accuracy of one only can be called in question; and that is the correction for diurnal range. The period of five years' observation, on which these corrections are founded, is not sufficiently long to determine the point with accuracy, as the existing data clearly enough evince. In default of more accurate information on

diurnal range in this part of England, I have let the corrections stand without alteration.

Reduction to sea-level.—The formula, by which this last step has been performed, is a modification of Sir George Shuckburg's—

$$h-h'=z\frac{h+h'}{60T},$$

given by Mr. G. Harvey Simmonds in his "Meteorological Tables," in which publication Tables are given, that greatly facilitate the operation.

The height of the cistern of the barometer at Somerset House having been 78 feet above mean sea-level, from 1774 to 1822, the reduction to sea-level has been made according to the values given in Table I.

Table I.—Reduction of the Barometer to Sea-level for an elevation of 78 feet.

	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°
ins.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·495–30·165	·092	·092	·091	·091	·091	·091	·091	·091	·090	·090	·090
30·165–29·835	·091	·091	·090	·090	·090	·090	·090	·090	·089	·089	·089
29·835–29·505	·090	·090	·089	·089	·089	·089	·089	·089	·088	·088	·088
29·505–29·175	·089	·089	·088	·088	·088	·088	·088	·088	·087	·087	·087

	36°	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°
ins.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·495–30·165	·090	·090	·089	·089	·089	·089	·089	·089	·089	·089	·089
30·165–29·835	·089	·089	·088	·088	·088	·088	·088	·088	·088	·088	·088
29·835–29·505	·088	·088	·087	·087	·087	·087	·087	·087	·087	·087	·087
29·505–29·175	·087	·087	·086	·086	·086	·086	·086	·086	·086	·086	·086

Table I.—Reduction of the Barometer to Sea-level for an elevation of 78 feet (*continued*).

ins.	47°	48°	49°	50°	51°	52°	53°	54°	55°	56°	57°
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·495 – 30·165	·088	·088	·088	·088	·088	·088	·087	·087	·087	·087	·087
30·165 – 29·835	·087	·087	·087	·087	·087	·087	·086	·086	·086	·086	·086
29·835 – 29·505	·086	·086	·086	·086	·086	·086	·085	·085	·085	·085	·085
29·505 – 29·175	·085	·085	·085	·085	·085	·085	·084	·084	·084	·084	·084

ins.	58°	59°	60°	61°	62°	63°	64°	65°	66°	67°	68°
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·495 – 30·165	·086	·086	·086	·086	·086	·085	·085	·085	·085	·085	·084
30·165 – 29·835	·085	·085	·085	·085	·085	·084	·084	·084	·084	·084	·083
29·835 – 29·505	·084	·084	·084	·084	·084	·083	·083	·083	·083	·083	·082
29·505 – 29·175	·083	·083	·083	·083	·083	·082	·082	·082	·082	·082	·081

The application of Table I. may be thus illustrated:—Supposing the corrected height of the barometer to be 30·200 inches, and the mean temperature of the air 30°, the reduction to sea-level is made by adding +·090 inch. If the barometer is 29·700 inches, and the temperature 68°, the correction becomes +·082 inch. The mean temperature at Somerset House of every month, from 1774 to 1843, has been calculated by Mr. Glaisher; and it is from the values he assigns that the corrections have been made: these should strictly be due to the temperature of the air at the time of the barometrical observations, viz. about 8 or 9 A.M. and 3 or 4 P.M.; but Mr. Glaisher's values may be accepted as sufficiently near for the purpose.

From 1823 to 1843 the barometer was 97 feet above mean sea-level, and the reduction to sea-level has been performed in accordance with the values given in Table II.

TABLE II.—Reduction of the Barometer to Sea-level for an elevation of 97 feet.

	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°
ins.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·495–30·165	·114	·114	·114	·113	·113	·113	·112	·112	·112	·112	·112
30·165–29·835	·113	·113	·113	·112	·112	·112	·111	·111	·111	·111	·111
29·835–29·505	·112	·112	·112	·111	·111	·111	·110	·110	·110	·110	·110
29·505–29·175	·111	·111	·111	·110	·110	·110	·109	·109	·109	·109	·109

	36°	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°
ins.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·495–30·165	·111	·111	·111	·111	·111	·110	·110	·110	·110	·110	·109
30·165–29·835	·110	·110	·110	·110	·110	·109	·109	·109	·109	·109	·108
29·835–29·505	·109	·109	·109	·109	·109	·108	·108	·108	·108	·108	·107
29·505–29·175	·108	·108	·108	·108	·108	·107	·107	·107	·107	·107	·106

	47°	48°	49°	50°	51°	52°	53°	54°	55°	56°	57°
ins.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·495–30·165	·109	·109	·109	·109	·108	·108	·108	·108	·108	·107	·107
30·165–29·835	·108	·108	·108	·108	·107	·107	·107	·107	·107	·106	·106
29·835–29·505	·107	·107	·107	·107	·106	·106	·106	·106	·106	·105	·105
29·505–29·175	·106	·106	·106	·106	·105	·105	·105	·105	·105	·104	·104

	58°	59°	60°	61°	62°	63°	64°	65°	66°	67°	68°
ins.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·495–30·165	·107	·107	·107	·107	·106	·106	·106	·106	·105	·105	·105
30·165–29·835	·106	·106	·106	·106	·105	·105	·105	·105	·104	·104	·104
29·835–29·505	·105	·105	·105	·105	·104	·104	·104	·104	·103	·103	·103
29·505–29·175	·104	·104	·104	·104	·103	·103	·103	·103	·102	·102	·102

In the same way Table III. shows the corrections to be applied to the barometer at Greenwich, which is 159 feet above the sea.

The respective temperatures of the air for each month are recorded in the volumes of Greenwich observations.

TABLE III.—Reduction of the Barometer to sea-level for an elevation of 159 feet.

ins.	25°	26°	27°	28°	29°	30°	31°	32°	33°	34°	35°
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·498–30·166	·186	·186	·185	·185	·184	·184	·184	·183	·183	·182	·182
30·166–29·834	·185	·185	·184	·184	·183	·183	·183	·182	·182	·181	·181
29·834–29·502	·184	·184	·183	·183	·182	·182	·182	·181	·181	·180	·180
29·502–29·170	·183	·183	·182	·182	·181	·181	·181	·180	·180	·179	·179

ins.	36°	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·498–30·166	·182	·181	·181	·180	·180	·180	·179	·179	·179	·178	·178
30·166–29·834	·181	·180	·180	·179	·179	·179	·178	·178	·178	·177	·177
29·834–29·502	·180	·179	·179	·178	·178	·178	·177	·177	·177	·176	·176
29·502–29·170	·179	·178	·178	·177	·177	·177	·176	·176	·176	·175	·175

ins.	47°	48°	49°	50°	51°	52°	53°	54°	55°	56°	57°
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·498–30·166	·178	·177	·177	·177	·176	·176	·176	·175	·175	·175	·174
30·166–29·834	·177	·176	·176	·176	·175	·175	·175	·174	·174	·174	·173
29·834–29·502	·176	·175	·175	·175	·174	·174	·174	·173	·173	·173	·172
29·502–29·170	·175	·174	·174	·174	·173	·173	·173	·172	·172	·172	·171

ins.	58°	59°	60°	61°	62°	63°	64°	65°	66°	67°	68°
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
30·498–30·166	·174	·173	·173	·172	·172	·172	·171	·171	·171	·170	·170
30·166–29·834	·173	·172	·172	·171	·171	·171	·170	·170	·170	·169	·169
29·834–29·502	·172	·171	·171	·170	·170	·170	·169	·169	·169	·168	·168
29·502–29·170	·171	·170	·170	·169	·169	·169	·168	·168	·168	·167	·167

TABLE IV.—Average Height of the Barometer at Somerset House, 78 feet above mean sea-level.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1774.	29·584	29·808	29·814	*29·768	29·831	29·844	29·941	29·897	29·750	30·105	29·806	30·098
1775.	29·836	*29·760	*29·796	30·003	29·982	*29·831	29·818	29·801	*29·733	29·840	29·759	30·062
1776.	29·717	29·408	*29·921	*30·022	29·970	29·812	29·847	*29·805	29·775	*29·996	29·862	29·881
1777.	29·784	29·686	*29·765	*29·940	*29·743	*29·907	29·838	*29·982	30·033	*29·780	29·953	*29·790
1778.	*29·720	*29·794	*29·763	*29·749	29·850	29·989	*29·886	*30·092	*29·940	*29·578	29·678	29·845
1779.	*30·288	*30·238	30·176	29·933	29·850	29·873	29·841	29·985	*29·856	29·930	29·618	*29·670
1780.	29·804	*29·950	29·902	29·635	29·902	29·966	*29·966	29·994	29·781	*29·642	29·858	30·303
1781.	29·916	*29·810	*30·187	29·857	*29·993	29·782	*30·009	*29·862				
1782.												
1783.												
1784.												
1785.												
1786.												
1787.	*30·196	*29·909	*29·798	*29·929	*29·902	*29·875	29·790	*29·968	*29·922	*29·710	*29.809	*29·687
1788.	*30·030	*29·609	29·690	*30·100	30·015	29·914	29·954	29·919	29·837	*30·133	30·103	29·950
1789.	29·752	29·794	*29·720	29·677	29·863	29·820	29·825	30·025	29·879	*29·678	29·706	29·863
1790.	30·073	30·257	30·263	29·860	29·881	30·017	29·816	29·943	29·987	29·878	29·813	29·881
1791.	29·561	29·951	30·205	29·757	30·005	29·908	29·865	30·026	30·075	29·676	29·681	29·656
1792.	29·669	29·988	29·776	29·881	29·967	*29·879	29·857	29·898	29·772	29·775	30·012	29·848
1793.	*30·028	29·802	29·844	29·891	30·024	29·943	29·991	29·923	29·960	29·972	29·789	29·737
1794.	*30·063	29·850	29·975	29·890	29·954	30·012	29·948	29·878	29·827	29·802	29·733	29·940
1795.	30·043	29·612	29·804	29·781	30·153	29·845	29·955	29·938	30·055	29·644	29·872	29·960

1796.	29·711	29·804	30·037	30·030	29·720	29·936	29·766	30·029	29·934	39·932	*29·808	29·850
1797.	30·106	30·320	29·940	29·756	*29·848	29·844	29·931	29·842	29·727	29·827	29·926	29·805
1798.	29·949	30·109	29·934	29·946	29·992	30·038	29·769	30·054	29·751	29·880	29·578	29·905
1799.	30·001	29·714	29·846	29·624	29·831	30·030	29·794	29·791	*29·782	29·793	29·872	29·941
1800.	29·501	*29·874	29·869	29·670	29·817	29·996	30·169	30·008	29·739	29·898	29·667	29·652
1801.	29·839	29·773	29·865	30·041	29·802	30·022	29·741	30·022	29·871	29·815	29·712	29·485
1802.	29·958	*29·768	*30·055	*30·012	*29·997	29·880	*29·826	30·001	30·021	29·783	29·631	29·738
1803.	29·670	29·881	30·026	29·873	29·941	29·999	30·096	30·021	30·098	30·053	29·501	29·611
1804.	29·602	30·041	29·630	29·707	29·901	30·083	*29·782	29·854	30·100	29·687	29·838	29·811
1805.	29·621	29·828	29·958	29·819	29·889	29·983	29·895	29·887	29·972	29·879	30·252	29·695
1806.	29·522	29·841	29·723	30·019	29·870	30·073	29·778	29·818	29·995	29·862	29·753	*29·595
1807.	30·062	29·779	*30·088	29·919	29·799	30·001	29·899	*29·870	29·809	29·862	39·529	29·945
1808.	29·852	30·106	30·126	29·863	29·899	29·945	29·909	29·841	*29·793	29·723	29·817	*29·785
1809.	*29·523	*29·743	30·044	29·778	29·884	29·897	29·818	29·723	29·699	30·134	29·933	29·568
1810.	30·133	29·870	29·686	29·799	29·864	30·057	29·773	*29·849	29·991	29·906	29·451	29·732
1811.	29·910	29·545	30·105	*29·712	29·744	*29·867	29·959	29·898	29·971	29·654	30·001	*29·766
1812.	29·893	39·661	*29·771	29·929	29·864	29·930	*29·957	29·961	30·050	*29·487	29·851	29·980
1813.	30·126	29·851	30·188	29·941	29·765	29·994	29·845	30·063	29·974	29·629	29·778	*29·822
1814.	29·568	30·093	29·760	29·836	29·959	29·989	29·733	29·928	30·036	29·779	29·740	*29·686
1815.	*29·866	29·818	29·750	*29·855	*29·889	29·822	30·011	29·924	29·947	*29·860	29·985	29·810
1816.	29·690	*29·873	*29·773	29·689	29·800	29·876	29·626	29·886	*29·894	29·794	*29·768	*29·739
1817.	*29·841	29·949	29·850	30·223	*29·707	29·828	29·790	29·686	29·917	*29·955	*29·966	*29·608
1818.	29·830	*29·752	*29·633	*29·688	29·832	29·995	30·016	30·050	29·832	29·857	29·843	30·080
1819.	29·792	29·666	29·881	29·773	*29·829	29·881	*29·948	29·957	29·926	*29·705	29·720	29·715
1820.	29·896	29·961	29·887	29·913	*29·758	29·917	29·910	*29·849	29·962	*29·602	29·841	29·946
1821.	*29·903	*30·260	29·625	29·637	29·849	30·019	29·890	29·893	29·825	*29·881	*29·777	*29·490
1822.	30·119	30·105	30·029	29·918	29·945	30·034	29·751	29·859	29·927	29·652	*29·765	30·077

TABLE V.—Average Height of the Barometer at Somerset House, 97 feet above mean sea-level.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1823.	29·671	29·433	29·797	29·824	29·890	29·869	29·787	29·858	29·953	29·682	*30·079	29·748
1824.	30·049	29·803	*29·786	29·846	*29·925	29·848	29·960	29·887	29·840	29·614	29·620	29·805
1825.	30·212	*30·136	30·078	29·966	*29·918	29·934	30·056	29·872	*29·822	29·909	29·685	29·532
1826.	30·021	29·925	*29·934	*29·905	29·920	30·129	29·844	29·885	29·828	29·839	29·760	29·838
1827.	*29·821	*30·009	*29·654	*29·912	*29·708	*29·870	30·016	29·933	29·923	29·697	29·949	29·792
1828.	29·902	29·769	29·859	29·706	29·789	29·915	29·628	29·782	29·854	30·014	29·845	29·931
1829.	29·750	30·020	29·800	29·482	29·968	29·949	29·733	29·813	29·693	29·960	29·929	30·089
1830.	29·942	29·864	30·034	29·694	29·789	29·746	29·866	29·806	29·706	30·157	29·777	29·570
1831.	29·811	29·795	29·809	29·643	29·824	29·865	29·873	29·842	29·832	29·794	29·834	29·731
1832.	29·940	30·025	29·853	29·921	29·861	29·773	30·004	29·779	30·039	29·995	29·797	29·914
1833.	30·169	29·487	29·792	29·687	30·013	29·730	29·913	29·871	29·809	29·743	29·864	29·649
1834.	29·686	30·103	30·154	30·091	29·934	29·900	29·848	29·788	29·997	29·970	29·884	30·253
1835.	30·037	29·794	29·883	30·050	29·795	29·949	29·958	29·882	29·646	29·720	29·897	30·129
1836.	29·895	29·761	29·485	29·786	30·097	29·831	29·884	29·943	29·779	29·759	29·580	29·759
1837.	29·902	29·903	29·920	29·737	29·881	29·929	29·894	29·909	29·820	30·051	29·799	29·920
1838.	29·878	29·561	29·765	29·728	29·827	29·794	29·911	29·841	29·910	29·920	29·509	30·036
1839.	29·855	29·937	29·762	30·023	29·877	29·828	29·829	29·916	29·590	29·952	29·642	29·676
1840.	29·761	29·878	30·197	29·991	29·828	29·902	29·811	29·851	29·730	29·903	29·582	30·084
1841.	29·758	29·750	29·872	29·796	29·813	29·880	29·781	29·836	29·708	29·514	29·724	29·656
1842.	29·972	29·939	29·830	29·995	29·859	29·958	29·901	29·952	29·778	29·928	29·665	30·063
1843.	29·732	29·565	29·849	29·760	29·718	29·780						

TABLE VI.—Average Height of the Barometer at the Royal Observatory, Greenwich, 159 feet above mean sea-level.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1840.												29·992
1841.	29·702	29·697	29·784	29·731	29·731	29·801	29·716	29·768	29·624	29·436	29·672	29·574
1842.	29·901	29·876	29·747	29·914	29·782	29·901	29·820	29·869	29·715	29·849	29·599	30·007
1843.	29·674	29·473	29·758	29·678	29·664	29·700	29·826	29·819	30·017	29·604	29·718	30·245
1844.	29·819	29·498	29·710	30·000	29·945	29·814	29·753	29·677	29·881	29·562	29·690	29·885
1845.	29·704	29·840	29·795	29·696	29·712	29·775	29·769	29·729	29·801	29·847	29·575	29·658
1846.	29·671	29·849	29·655	29·589	29·779	29·866	29·757	29·777	29·824	29·516	29·821	29·697
1847.	29·738	29·783	29·889	29·653	29·682	29·805	29·923	29·877	29·825	29·803	29·905	29·691
1848.	29·816	29·517	29·505	29·589	29·926	29·642	29·836	29·732	29·832	29·646	29·785	29·807
1849.	29·717	30·106	29·915	29·517	29·766	29·868	29·789	29·841	29·767	29·744	29·743	29·795
1850.	29·854	29·828	30·039	29·594	29·714	29·886	29·789	29·787	29·930	29·681	29·728	29·914
1851.	29·642	29·891	29·600	29·726	29·891	29·895	29·708	29·890	30·025	29·726	29·781	30·135
1852.	29·589	29·857	30·007	29·945	29·786	29·560	29·857	29·649	29·739	29·687	29·465	29·581
1853.	29·570	29·525	29·780	29·710	29·754	29·729	29·728	29·793	29·833	29·558	29·941	29·804
1854.	29·618	30·041	30·186	29·985	29·667	29·735	29·807	29·889	30·031	29·724	29·728	29·768
1855.	29·998	29·593	29·535	29·933	29·679	29·863	29·769	29·874	29·966	29·527	29·864	29·761
1856.	29·468	29·899	30·011	29·615	29·647	29·877	29·831	29·746	29·652	29·991	29·902	29·646
1857.	29·634	29·952	29·720	29·632	29·786	29·858	29·847	29·836	29·786	29·695	29·942	30·155
1858.	30·171	29·842	29·765	29·779	29·709	29·915	29·781	29·826	29·865	29·834	29·750	29·771
1859.	30·037	29·823	29·806	29·614	29·789	29·766	29·937	29·818	29·709	29·523	29·824	29·623
1860.	29·514	29·857	29·655	29·796	29·746	29·613	29·845	29·556	29·761	29·856	29·696	29·491
1861.	30·011	29·686	29·614	29·999	29·924	29·782	29·606	29·865	29·717	29·842	29·561	29·974
1862.	29·705	29·905	29·498	29·847	29·726	29·718	29·762	29·785	29·859	29·726	29·793	29·865

TABLE VII.—Barometer at Sea-level.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1774.	29·672	29·895	29·901	29·854	29·917	29·929	30·026	29·982	29·835	30·192	29·893	30·186	29·940
1775.	29·924	29·847	29·883	30·090	30·068	29·914	29·901	29·885	29·817	29·927	29·846	30·150	29·938
1776.	29·806	29·494	30·009	30·109	30·057	29·896	29·931	29·889	29·860	30·082	29·950	29·969	29·921
1777.	29·872	29·774	29·851	30·028	29·828	29·993	29·923	30·056	30·118	29·866	30·041	29·878	29·936
1778.	29·808	29·882	29·850	29·835	29·936	30·074	29·969	30·176	30·026	29·664	29·765	29·933	29·910
1779.	30·378	30·327	30·264	30·020	29·936	29·958	29·925	30·069	29·941	30·016	29·705	29·757	30·025
1780.	29·893	30·039	29·989	29·722	29·988	30·051	30·050	30·078	29·865	29·728	29·946	30·392	29·978
1781.	30·004	29·897	30·276	29·944	30·079	29·865	30·093	29·946					
1782.													
1783.													
1784.													
1785.													
1786.													
1787.	30·285	29·997	29·885	30·017	29·989	29·960	29·873	30·053	30·008	29·796	29·896	29·774	29·961
1788.	30·118	29·696	29·777	30·187	30·101	29·999	30·039	30·004	29·922	30·220	30·191	30·040	30·024
1789.	29·840	29·791	29·808	29·764	29·948	29·905	29·909	30·110	29·965	29·764	29·793	29·950	29·879
1790.	30·161	30·347	30·352	29·947	29·967	30·102	29·900	30·028	30·073	29·965	29·900	29·969	30·059
1791.	29·648	30·040	30·294	29·843	30·092	29·993	29·949	30·110	30·160	29·762	29·768	29·744	29·950
1792.	29·757	30·076	29·863	29·968	30·054	29·965	29·941	29·982	29·857	29·861	30·100	29·935	29·947
1793.	30·117	29·889	29·931	29·979	30·111	30·029	30·075	30·008	30·046	30·058	29·876	29·824	29·995
1794.	30·152	29·937	30·063	29·977	30·041	30·097	30·032	29·963	29·912	29·888	29·820	30·028	29·993
1795.	30·134	29·700	29·891	29·868	30·239	29·930	30·040	30·023	30·140	29·729	29·960	30·048	29·975
1796.	29·797	29·891	30·125	30·117	29·806	30·022	29·850	30·114	30·019	30·019	29·895	29·939	29·966
1797.	30·195	30·410	30·028	29·843	29·934	29·929	30·015	29·926	29·812	29·913	30·014	29·892	29·993
1798.	30·037	30·197	30·022	30·033	30·078	30·123	29·853	30·138	29·836	29·967	29·665	29·994	29·995
1799.	30·090	29·801	29·933	29·711	29·917	30·116	29·878	29·875	29·867	29·879	29·960	30·030	29·921

1800.	29·587	29·963	29·957	29·757	29·902	30·082	30·254	30·092	29·823	29·985	29·754	29·739	29·908
1801.	29·927	29·860	29·953	30·129	29·887	30·107	29·826	30·106	29·956	29·901	29·799	29·572	29·919
1802.	30·047	29·855	30·143	30·099	30·084	29·965	29·911	30·085	30·106	29·870	29·718	29·825	29·976
1803.	29·758	29·969	30·114	29·960	30·028	30·085	30·180	30·105	30·184	30·140	29·587	29·698	29·984
1804.	29·689	30·129	29·717	29·794	29·986	30·168	29·866	29·939	30·185	29·772	29·926	29·899	29·923
1805.	29·709	29·915	30·046	29·906	29·976	30·069	29·980	29·971	30·057	29·966	30·341	29·782	29·976
1806.	29·609	29·929	29·810	30·107	29·956	30·158	29·862	29·901	30·080	29·948	29·839	29·681	29·907
1807.	30·150	29·866	30·096	30·007	29·884	30·086	29·983	29·954	29·894	29·948	29·615	30·033	29·960
1808.	29·940	30·194	30·214	29·951	29·984	30·030	29·993	29·924	29·878	29·809	29·904	29·872	29·974
1809.	29·611	29·830	30·132	29·865	29·970	29·982	29·902	29·807	29·784	30·221	30·021	29·655	29·898
1810.	30·222	29·958	29·773	29·885	29·950	30·142	29·857	29·933	30·076	29·992	29·537	29·819	29·929
1811.	29·999	29·632	30·193	29·798	29·829	29·952	30·044	29·983	30·056	29·739	30·089	29·853	29·931
1812.	29·982	29·748	29·858	30·017	29·950	30·016	30·042	30·046	30·136	29·572	29·938	30·069	29·948
1813.	30·218	29·938	30·276	30·029	29·850	30·080	29·929	30·148	30·060	29·715	29·865	29·909	30·001
1814.	29·657	30·182	29·848	29·922	30·046	30·075	29·817	30·013	30·122	29·865	29·827	29·773	29·929
1815.	29·955	29·905	29·837	29·941	29·975	29·906	30·096	30·009	30·031	29·946	30·073	29·897	29·964
1816.	29·777	29·961	29·860	29·776	29·886	29·962	29·711	29·971	29·979	29·880	29·855	29·826	29·870
1817.	29·928	30·037	29·937	30·312	29·793	29·912	29·874	29·771	30·003	30·043	30·053	29·695	29·947
1818.	29·917	29·840	29·720	29·775	29·917	30·079	30·100	30·134	29·916	29·942	29·929	30·168	29·953
1819.	29·879	29·753	29·969	29·859	29·914	29·967	30·033	30·041	30·011	29·791	29·807	29·802	29·902
1820.	29·985	30·049	29·975	30·000	29·843	30·003	29·995	29·933	30·048	29·688	29·928	30·034	29·957
1821.	29·991	30·350	29·712	29·723	29·935	30·105	29·975	29·977	29·909	29·968	29·863	29·576	29·924
1822.	30·207	30·193	30·116	30·005	30·031	30·118	29·834	29·943	30·013	29·737	29·851	30·165	30·018
1823.	29·781	29·541	29·905	29·932	29·996	29·975	29·892	29·964	30·059	29·789	30·188	29·855	29·906
1824.	30·159	29·912	29·894	29·955	30·032	29·954	30·065	29·993	29·946	29·720	29·727	29·913	29·939
1825.	30·323	30·246	30·188	30·074	30·025	30·040	30·160	29·977	29·927	30·016	29·793	29·640	30·034
1826.	30·132	30·034	30·043	30·013	30·027	30·234	29·948	29·990	29·933	29·946	29·868	29·947	30·010
1827.	29·931	30·120	29·762	30·020	29·814	29·976	30·121	30·039	30·029	29·803	30·058	29·899	29·964
1828.	30·011	29·877	29·968	29·813	29·895	30·021	29·732	29·887	29·960	30·121	29·953	30·039	29·940
1829.	29·860	30·130	29·909	29·589	30·074	30·055	29·838	29·918	29·799	30·068	30·038	30·199	29·956
1830.	30·053	29·974	30·142	29·801	29·894	29·851	29·971	29·911	29·812	30·264	29·884	29·679	29·939
1831.	29·920	29·903	29·917	29·750	29·930	29·971	29·978	29·947	29·937	29·899	29·942	29·839	29·911
1832.	30·050	30·135	29·962	30·029	29·968	29·878	30·109	29·883	30·145	30·102	29·905	30·023	30·016
1833.	30·280	29·594	29·901	29·794	30·119	29·835	30·018	29·977	29·915	29·850	29·973	29·756	29·918
1834.	29·793	30·212	30·263	30·199	30·041	30·005	29·953	29·892	30·103	30·077	29·993	30·363	30·074
1835.	30·147	29·902	29·992	30·158	29·901	30·055	30·063	29·987	29·751	29·827	30·006	30·239	30·002

TABLE VII.—Barometer at Sea-level (*continued*).

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1836.	30·005	29·870	29·592	29·894	30·204	29·936	29·989	30·049	29·885	29·866	29·688	29·868	29·904
1837.	30·012	30·012	30·030	29·846	29·989	30·035	29·999	30·014	29·925	30·158	29·907	30·029	29·996
1838.	29·989	29·671	29·873	29·836	29·933	29·899	30·016	29·947	30·016	30·027	29·617	30·146	29·914
1839.	29·965	30·046	29·871	30·132	29·984	29·933	29·934	30·022	29·695	30·060	29·749	29·784	29·931
*1840.	29·869	29·988	30·308	30·099	29·934	30·008	29·916	29·956	29·836	30·011	29·690	30·195	29·984
1841.	29·867	29·859	29·980	29·903	29·918	29·986	29·886	29·941	29·813	29·620	29·832	29·764	29·864
1842.	30·083	30·048	29·937	30·103	29·966	30·063	30·007	30·056	29·883	30·036	29·773	30·171	30·010
†1843.	29·852	29·652	29·935	29·854	29·838	29·873	29·997	29·989	30·189	29·779	29·895	30·424	29·943
1844.	29·997	29·677	29·887	30·175	30·120	29·984	29·923	29·849	30·054	29·737	29·867	30·067	29·948
1845.	29·883	30·022	29·975	29·872	29·887	29·945	29·940	29·901	29·974	30·023	29·751	29·835	29·920
1846.	29·848	30·027	29·832	29·765	29·952	30·036	29·926	29·947	29·995	29·690	29·997	29·878	29·911
1847.	29·918	29·963	30·067	29·829	29·855	29·977	30·093	30·048	29·998	29·977	30·082	29·868	29·976
1848.	29·996	29·694	29·682	29·764	30·098	29·813	30·007	29·903	30·005	29·820	29·962	29·984	29·897
1849.	29·895	30·284	30·093	29·694	29·939	30·041	29·959	30·012	29·938	29·918	29·920	29·973	29·975
1850.	30·035	30·004	30·218	29·770	29·888	30·057	29·959	29·958	30·104	29·857	29·904	30·093	29·990
1851.	29·819	30·070	29·777	29·903	30·066	30·067	29·879	30·061	30·198	29·900	29·960	30·314	30·004
1852.	29·766	30·036	30·186	30·122	29·960	29·733	30·036	29·819	29·912	29·862	29·639	29·756	29·905
1853.	29·747	29·706	29·958	29·886	29·928	29·901	29·899	29·964	30·006	29·732	30·119	29·984	29·906
1854.	29·796	30·220	30·365	30·161	29·841	29·908	29·978	30·060	30·204	29·899	29·906	29·946	30·027
1855.	30·179	29·775	29·714	30·110	29·854	30·036	29·939	30·045	30·139	29·701	30·043	29·941	29·959
1856.	29·645	30·077	30·190	29·791	29·822	30·049	30·001	29·915	29·825	30·166	30·081	29·824	29·952
1857.	29·813	30·131	29·897	29·808	29·959	30·029	30·017	30·006	29·957	29·869	30·119	30·332	29·998
1858.	30·352	30·022	29·943	29·955	29·883	30·085	29·951	29·996	30·037	30·009	29·928	29·949	30·012
1859.	30·216	30·000	29·982	29·790	29·963	29·936	30·106	29·988	29·881	29·697	30·001	29·802	29·950
1860.	29·692	30·038	29·833	29·973	29·919	29·786	30·018	29·728	29·935	30·031	29·874	29·670	29·878
1861.	30·192	29·863	29·791	30·177	30·099	29·953	29·776	30·036	29·889	30·016	29·739	30·153	29·977
1862.	29·883	30·084	29·674	30·023	29·899	29·891	29·933	29·956	30·032	29·900	29·971	30·043	29·941

* Barometer at Greenwich reduced to Sea-level.

1840.	....	....	....	....	....	....	....	....	....	....	....	30·174	
1841.	29·883	29·877	29·960	29·907	29·903	29·974	29·888	29·939	29·796	29·610	29·849	29·752	29·862
1842.	30·083	30·055	29·923	30·091	29·956	30·072	29·991	30·039	29·888	30·026	29·776	30·184	30·007

† Barometer at Somerset House reduced to Sea-level.

1843.	29·840	29·674	29·958	29·867	29·824	29·885							

TABLE VIII.—Difference of the Barometer in each Month from the average Monthly Height.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.
1774.	−·282	−·063	−·068	−·084	−·047	−·069	+·061	−·003	−·141	+·281	−·004	+·247	−·015
1775.	−·030	−·111	−·086	+·152	+·104	−·084	−·064	−·100	−·159	+·016	−·051	+·211	−·017
1776.	−·148	−·464	+·040	+·171	+·093	−·102	−·034	−·096	−·116	+·171	+·053	+·030	−·034
1777.	−·082	−·184	−·118	+·090	−·136	−·005	−·042	+·071	+·142	−·045	+·144	−·061	−·019
1778.	−·146	−·076	−·119	−·103	−·028	+·076	+·004	+·191	+·050	−·247	−·132	−·006	−·045
1779.	+·424	+·369	+·295	+·082	−·028	−·040	−·040	+·084	−·035	+·105	−·192	−·182	+·070
1780.	−·061	+·081	+·020	−·216	+·024	+·053	+·085	+·093	−·111	−·183	+·049	+·453	+·023
1781.													
1782.													
1783.													
1784.													
1785.													
1786.													
1787.	+·331	+·039	−·084	+·079	+·025	−·038	−·092	+·068	+·032	−·115	−·001	−·165	+·006
1788.	+·164	−·262	−·192	+·249	+·137	+·001	+·074	+·019	−·054	+·309	+·294	+·101	+·069
1789.	−·114	−·167	−·161	−·174	−·016	−·093	−·056	+·125	−·011	−·147	−·104	+·011	−·076
1790.	+·207	+·389	+·383	+·009	+·003	+·104	−·065	+·043	+·097	+·054	+·003	+·030	+·104
1791.	−·306	+·082	+·325	−·095	+·128	−·005	−·016	+·125	+·184	−·149	−·129	−·195	−·005
1792.	−·197	+·118	−·106	+·030	+·090	−·033	−·024	−·003	−·119	−·050	+·203	−·004	−·008
1793.	+·163	−·069	−·038	+·041	+·147	+·031	+·110	+·023	+·070	+·147	−·021	−·115	+·040
1794.	+·198	−·021	+·094	+·039	+·077	+·099	+·067	−·022	−·064	−·023	−·077	+·089	+·038
1795.	+·180	−·258	−·078	−·070	+·275	−·068	+·075	+·038	+·164	−·182	+·063	+·109	+·020
1796.	−·157	−·067	+·156	+·179	−·158	+·024	−·115	+·129	+·043	+·108	−·002	·000	+·011
1797.	+·241	+·452	+·059	−·095	−·030	−·069	+·050	−·059	−·164	+·002	+·117	−·047	+·038
1798.	+·083	+·239	+·053	+·095	+·114	+·125	−·112	+·153	−·140	+·056	−·232	+·055	+·040
1799.	+·136	−·157	−·036	−·227	−·047	+·118	−·087	−·110	−·109	−·032	+·063	+·091	−·034
1800.	−·367	+·005	−·012	−·181	−·062	+·084	+·289	+·107	−·153	+·074	−·143	−·200	−·047
1801.	−·027	−·098	−·016	+·191	−·077	+·109	−·139	+·121	−·020	−·010	−·098	−·367	−·036

TABLE VIII. (*continued*).

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.	inch.
1802.	+·093	−·103	+·174	+·161	+·120	−·033	−·054	+·100	+·130	−·041	−·179	−·114	+·021
1803.	−·196	+·011	+·145	+·022	+·064	+·087	+·215	+·120	+·208	+·229	−·310	−·241	+·029
1804.	−·265	+·171	−·252	−·144	+·022	+·170	−·099	−·046	+·209	−·139	+·029	−·040	−·032
1805.	−·245	−·043	+·077	−·032	+·012	+·071	+·015	−·014	+·081	+·055	+·444	−·157	+·021
1806.	−·345	−·029	−·159	+·169	−·008	+·160	−·103	−·084	+·104	+·037	−·058	−·258	−·048
1807.	+·196	−·092	+·127	+·069	−·080	+·088	+·018	−·031	−·082	+·037	−·282	+·094	+·005
1808.	−·014	+·236	+·245	+·013	+·020	+·032	+·028	−·061	−·098	−·102	+·007	−·067	+·019
1809.	−·343	−·128	+·163	−·073	+·006	−·016	−·063	−·178	−·192	+·310	+·124	−·284	−·057
1810.	+·268	·000	−·196	−·053	−·014	+·144	−·108	−·052	+·100	+·081	−·360	−·120	−·026
1811.	+·045	−·326	+·224	−·140	−·135	−·046	+·079	−·002	+·080	−·172	+·192	−·086	−·024
1812.	+·028	−·210	−·111	+·079	−·014	+·018	+·077	+·061	+·160	−·339	+·041	+·130	−·007
1813.	+·264	−·020	+·307	+·091	−·114	+·082	−·036	+·163	+·084	−·196	−·032	−·030	+·046
1814.	−·297	+·224	−·121	−·016	+·082	+·077	−·148	+·028	+·146	−·046	−·070	−·166	−·026
1815.	+·001	−·053	−·132	+·003	+·011	−·092	+·131	+·024	+·055	+·035	+·176	−·042	+·009
1816.	−·177	+·003	−·109	−·162	−·078	−·036	−·254	−·014	+·003	−·031	−·042	−·113	−·085
1817.	−·026	+·079	−·032	+·374	−·171	−·086	−·091	−·214	+·027	+·132	+·156	−·244	−·008
1818.	−·037	−·118	−·249	−·163	−·047	+·081	+·135	+·149	−·060	+·031	+·032	+·229	−·002
1819.	−·075	−·205	·000	−·079	−·050	−·031	+·068	+·056	+·035	−·120	−·090	−·137	−·053
1820.	+·031	+·091	+·006	+·062	−·121	+·005	+·030	−·052	+·072	−·223	+·031	+·095	+·002
1821.	+·037	+·392	−·257	−·215	−·029	+·107	+·010	−·008	−·067	+·057	−·034	−·363	−·031
1822.	+·253	+·235	+·147	+·067	+·067	+·120	−·131	−·042	+·037	−·174	−·046	+·226	+·063
1823.	−·173	−·417	−·064	−·006	+·032	−·023	−·073	−·021	+·083	−·122	+·291	−·084	−·049
1824.	+·205	−·046	−·075	+·017	+·068	−·044	+·100	+·008	−·030	−·191	−·170	−·026	−·016
1825.	+·369	+·288	+·219	+·136	+·061	+·042	+·195	−·008	−·049	+·105	−·104	−·299	+·079
1826.	+·178	+·076	+·074	+·075	+·063	+·236	−·017	+·005	−·043	+·035	−·029	+·008	+·055
1827.	−·023	+·162	−·207	+·082	−·150	−·022	+·156	+·054	+·053	−·108	+·161	−·040	+·009
1828.	+·057	−·081	−·001	−·125	−·069	+·023	−·233	−·098	−·016	+·210	+·056	+·100	−·015
1829.	−·094	+·172	−·060	−·349	+·110	+·057	−·127	−·067	−·177	+·157	+·141	+·260	+·001

1830.	+·099	+·016	+·173	−·137	−·070	−·147	+·006	−·074	−·164	+·353	−·013	−·260	−·019
1831.	−·034	−·055	−·052	−·188	−·034	−·027	+·013	−·038	−·039	−·012	+·045	−·100	−·044
1832.	+·096	+·177	−·007	+·091	+·004	−·120	+·144	−·102	+·169	+·191	+·008	+·084	+·061
1833.	+·326	−·364	−·068	−·144	+·155	−·163	+·053	−·008	−·061	−·061	+·076	−·183	−·037
1834.	−·161	+·254	+·294	+·261	+·077	+·007	−·012	−·093	+·127	+·166	+·096	+·424	+·119
1835.	+·193	−·056	+·023	+·220	−·063	+·057	+·098	+·002	−·225	−·084	+·109	+·300	+·047
1836.	+·051	−·088	−·377	−·044	+·240	−·062	+·024	+·064	−·091	−·045	−·209	−·071	−·051
1837.	+·058	+·054	+·061	−·092	+·025	+·037	+·034	+·029	−·051	+·247	+·010	+·090	+·041
1838.	+·035	−·287	−·096	−·102	−·031	−·099	+·051	−·038	+·040	+·116	−·280	+·207	−·041
1839.	+·011	+·088	−·098	+·194	+·020	−·065	−·031	+·037	−·281	+·149	−·148	−·155	−·024
1840.	−·085	+·030	+·339	+·161	−·030	+·010	−·049	−·029	−·140	+·100	−·207	+·256	+·029
1841.	−·087	−·099	+·011	−·035	−·046	−·012	−·079	−·044	−·163	−·291	−·065	−·175	−·091
1842.	+·129	+·090	−·032	+·165	+·002	+·065	+·042	+·071	−·093	+·125	−·124	+·232	+·055
1843.	−·102	−·306	−·034	−·084	−·126	−·125	+·032	+·004	+·213	−·132	−·002	+·485	−·012
1844.	+·043	−·281	−·082	+·237	+·156	−·014	−·042	−·136	+·078	−·174	−·030	+·128	−·007
1845.	−·071	+·064	+·006	−·066	−·077	−·053	−·025	−·084	−·002	+·112	−·146	−·104	−·035
1846.	−·106	+·069	−·137	−·173	−·012	+·038	−·039	−·038	+·019	−·221	+·100	−·061	−·044
1847.	−·036	+·005	+·098	−·109	−·109	−·021	+·128	+·063	+·022	+·066	+·185	−·071	+·021
1848.	+·042	−·264	−·287	−·174	+·134	−·185	+·042	−·082	+·029	−·091	+·065	+·045	−·058
1849.	−·059	+·326	+·124	−·244	−·025	+·043	−·006	+·027	−·038	+·007	+·023	+·034	+·020
1850.	+·081	+·046	+·249	−·168	−·076	+·059	−·006	−·027	+·128	−·054	+·007	+·154	+·035
1851.	−·135	+·112	−·192	−·035	+·102	+·069	−·086	+·076	+·222	−·011	+·063	+·375	+·049
1852.	−·188	+·078	+·217	+·184	−·004	−·265	+·071	−·166	−·064	−·049	−·258	−·183	−·050
1853.	−·207	−·252	−·011	−·052	−·036	−·097	−·066	−·021	+·030	−·179	+·222	+·045	−·049
1854.	−·158	+·262	+·396	+·223	−·123	−·090	+·013	+·075	+·228	−·012	+·009	+·007	+·072
1855.	+·225	−·183	−·255	+·172	−·110	+·038	−·026	+·060	+·163	−·210	+·146	+·002	+·004
1856.	−·309	+·119	+·221	−·147	−·142	+·051	+·036	−·070	−·151	+·255	+·184	−·115	−·003
1857.	−·141	+·173	−·072	−·130	−·005	+·031	+·052	+·021	−·019	−·042	+·222	+·393	+·043
1858.	+·398	+·064	−·026	+·017	−·081	+·087	−·014	+·011	+·061	+·098	+·031	+·010	+·057
1859.	+·262	+·042	+·013	−·148	−·001	−·062	+·141	+·003	−·095	−·214	+·104	−·137	−·005
1860.	−·262	+·080	−·136	+·035	−·045	−·212	−·053	−·257	−·041	+·120	−·023	−·269	−·077
1861.	+·238	−·095	−·178	+·239	+·135	−·045	−·189	+·051	−·087	+·105	−·158	+·214	+·022
1862.	−·071	+·126	−·295	+·085	−·065	−·107	−·032	−·029	+·056	−·011	+·074	+·104	−·014

TABLE IX.—Barometer in London reduced to mean Sea-level on an average of 83 years.

	Average height.	Difference from the annual average.	Probable variation.	Highest average.	Date.	Lowest average.	Date.
	ins.	in.	in.	ins.		ins.	
January	29·954	−0·001	0·127	30·378	1779	29·587	1800
February	29·958	+0·003	0·129	30·410	1797	29·494	1776
March..............	29·969	+0·014	0·114	30·365	1854	29·592	1836
April	29·938	−0·017	0·098	30·312	1817	29·589	1829
May	29·964	+0·009	0·062	30·239	1795	29·793	1817
June	29·998	+0·043	0·059	30·234	1826	29·733	1852
July	29·965	+0·010	0·061	30·254	1800	29·711	1816
August	29·985	+0·030	0·057	30·176	1778	29·728	1860
September	29·976	+0·021	0·079	30·204	1854	29·695	1839
October	29·911	−0·044	0·101	30·264	1830	29·572	1812
November	29·897	−0·058	0·099	30·341	1805	29·537	1810
December	29·939	−0·016	0·127	30·424	1843	29·572	1801
Year............	29·955	....	0·030				

TABLE X.—Showing the Range in the average Monthly Height of the Barometer in a period of 83 years, or 996 months.

Barometer between	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
ins. ins.													
30·5—30·4	......	1	......	......	......	......	......	......	......	......	......	1	2
30·4—30·3	3	3	3	1	......	......	......	......	......	......	1	4	15
30·3—30·2	6	4	6	......	2	1	1	......	1	3	......	1	25
30·2—30·1	12	9	10	14	4	9	6	9	14	6	5	9	107
30·1—30·0	10	19	10	17	18	31	22	26	23	16	13	13	210
30·0—29·9	17	16	23	15	38	32	35	37	22	18	24	16	293
29·9—29·8	16	15	18	18	20	8	16	9	19	18	19	20	197
29·8—29·7	10	7	9	16	1	2	3	2	3	16	13	10	92
29·7—29·6	8	6	2	1	......	......	......	......	1	5	6	7	36
29·6—29·5	1	2	1	1	......	......	......	......	......	1	2	2	10
29·5—29·4	......	1	......	......	......	......	......	......	......	......	......	......	1

TABLE XI.—Average Monthly Height of the Barometer, arranged in Decades.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
1774—1780 } 1787—1789 }	29.9596	29.8742	29.9217	29.9626	29.9768	29.9679	29.9546	30.0302	29.9357	29.9255	29.9026	30.0029	29.9512
1790—1799	30.0088	30.0288	30.0502	29.9286	30.0239	30.0306	29.9533	30.0167	29.9722	29.9041	29.8958	29.9403	29.9794
1800—1809	29.8027	29.9510	30.0182	29.9575	29.9657	30.0732	29.9757	29.9884	29.9947	29.9560	29.8504	29.7756	29.9425
1810—1819	29.9534	29.8954	29.9271	29.9314	29.9110	30.0091	29.9503	30.0049	30.0390	29.8485	29.8973	29.8811	29.9374
1820—1829	30.0380	30.0452	29.9472	29.9124	29.9672	30.0481	29.9560	29.9621	29.9623	29.8856	29.9267	29.9267	29.9648
1830—1839	30.0214	29.9319	29.9543	29.9439	29.9963	29.9398	30.0030	29.9629	29.9184	30.0130	29.8664	29.9726	29.9602
1840—1849	29.9208	29.9214	29.9696	29.9058	29.9507	29.9726	29.9654	29.9602	29.9685	29.8611	29.8769	30.0159	29.9428
1850—1859	29.9368	30.0041	30.0230	29.9296	29.9164	29.9801	29.9765	29.9812	30.0263	29.8692	29.9700	29.9941	29.9703

TABLE XII.—Difference of the average Monthly Height of the Barometer for each Decade, from the average of 83 years.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in
1774—1780 } 1787—1789 }	+.006	−.084	−.047	+.025	+.013	−.030	−.010	+.045	−.040	+.014	+.006	+.064	−.004
1790—1799	+.055	+.071	+.081	−.009	+.060	+.032	−.012	+.031	−.004	−.007	−.001	+.001	+.024
1800—1809	−.151	−.007	+.049	+.020	+.002	+.075	+.011	+.003	+.019	+.045	−.047	−.163	−.013
1810—1819	−.001	−.063	−.042	−.007	−.053	+.011	−.015	+.020	+.063	−.062	.000	−.058	−.018
1820—1829	+.084	+.087	−.022	−.026	+.003	+.050	−.009	−.023	−.014	−.025	+.030	−.012	+.010
1830—1839	+.067	−.026	−.015	+.006	+.032	−.058	+.038	−.022	−.058	+.102	−.031	+.034	+.005
1840—1849	−.033	−.037	+.001	−.032	−.013	−.025	.000	−.025	−.007	−.050	−.020	+.077	−.012
1850—1859	−.017	+.046	+.054	−.008	−.048	−.018	+.012	−.004	+.050	−.042	+.073	+.055	+.015

XXVIII. *On the Rain-fall of the British Isles during the years* 1860, 1861, 1862. By G. J. Symons, Esq.

Never having brought under the notice of this Society any communication respecting rain-fall, although I have now devoted the whole of my leisure time, for several years, to the subject, it will not perhaps be thought inappropriate to sketch briefly the mode in which the inquiry has been conducted, and the amount of information already collected.

My attention was first drawn to the subject by a paragraph in the Registrar-General's Quarterly Return for June 1859, in which Mr. Glaisher stated:—"The deficiency in the years 1854, 1855, 1856, 1857, and 1858 amounts to the average fall of one year, namely, 25 inches. From a careful examination of the fall of rain from the year 1815, it would seem that *the annual fall is becoming smaller*, and that there is but little probability that this large deficiency will be made up by excesses in future years."

This remark was made the basis of a £20 premium, offered through the Meteorological Society of Scotland, by the Marquess of Tweeddale, for the best essay on the question whether the fall of rain in *Scotland* was decreasing. The author of the essay, to which the prize was awarded, argued for an equal fall in all years—neither an increase nor a decrease. This is just what might have been expected; for, while Mr. Glaisher merely stated what was taking place at Greenwich, Mr. Jamieson collected twenty-two registers from stations very widely separated, even including foreign countries. Taking so wide an area, it is not at all surprising that he found the compensation perfect, the increase at one place neutralizing the decrease at another.

There is no doubt whatever that the Greenwich fall did decrease in a remarkable manner during the above years, but that this decrease was general nobody ever asserted.

This was, however, by no means the first occasion on which attention had been called to results obtained from long-continued observation at one place. A paragraph from Professor Forbes's Report to the British Association in 1832 will illustrate this. He writes, "M. Arago has shown that the fall of rain at Paris has *not altered* for 130 years; and, in order to show that M. Flauguergue's idea of a gradual *increase* cannot be general, quotes the observations at Marseilles, where a *decrease* is shown in 50 years. At Milan an *increase* has been thought to be proved by 54 years' ob-

servations." It seems, from this, pretty evident that observations at any *one* spot even for half a century are not sufficient to determine the general law.

Here then was an important question, not only in a meteorological, but also in a sanitary, an engineering, and an agricultural point of view, of which no thorough investigation had been made. To answer it, by collecting all known rain-registers and discussing them, apparently required little besides perseverance and careful work, quite consistent with the faithful discharge of other duties—a work, moreover, in which my previous studies at the British Museum and other libraries would be most valuable. I therefore resolved to undertake it.

The first step was obviously to collect all the observations. The next step, namely, the discussion of the results, must await the completion, or partial completion, of this primary object.

Circulars were therefore sent to all the observers of this Society and of the Meteorological Society of Scotland, as well as to all others who were known to keep records of rain-fall. Then a search was commenced in modern periodicals for records of rain-fall, and correspondence (through the courtesy of the editors) opened with the observers themselves. By this means, and powerfully aided by the personal exertion of many of the observers, a body of rather more than 600 persons are now helping forward this inquiry.

In order to supply a certain amount of thoroughly trustworthy information, the returns for each current year are published as soon as possible after its termination.

Cordially assisted by my friend Mr. G. Harvey Simmonds, I have commenced a visitation of the various places where observations are made, not merely with a view to testing the accuracy of the instruments, but also to ascertain the suitability of the position and accurately to determine the elevation of the receiving surface above the ground and above mean sea-level. Of course, as the stations are scattered over so large an area, Guernsey and Jersey in the S. to the Shetlands in the N., Norwich in the E. to Valentia and Galway in the W., this is a formidable undertaking. But, with 50 stations visited in the first year, we may reasonably hope, if not to test them all, yet by examining a large proportion of them, materially to increase the reliance to be placed on all the observations and on the deductions hereafter to be made from them.

Another plan, by which I hope to increase and diffuse trust-

worthy statistics on this subject is by issuing, immediately after the close of each month, at the cost of printing, paper, and postage, a monthly circular giving for each of 20 stations (10 in England, 5 in Scotland, and 5 in Ireland) the total fall of rain, the heaviest fall in 24 hours, the date on which it fell, the number of rainy days in each month, and any general remarks which the gentlemen who contribute the reports may have to offer. This proposal has been so warmly supported, that it is intended in 1864, by doubling the number of stations, to make these circulars still more worthy of their object.

Reverting for a moment to the collection of records of the rain-fall in past years, I may just mention that I have already collected and tabulated the monthly fall at about 900 stations, amounting in the gross to about 8000 years, and extending back to A.D. 1677. As possibly some persons may doubt whether any reliance can be placed on such antiquated observations, it may be well to state that scrupulous care was evidently taken to secure accuracy; and the results, so far as they have been examined, appear worthy of confidence—in fact, far more so than some existing stations, more than one of which I have had to refuse, owing to improper instruments or position.

Having thus briefly sketched the steps by which this investigation has advanced, I proceed to offer some remarks on the rain-fall of the past year, including also incidentally that of the two previous years.

For the purposes of the present paper, *two* groups of 60 stations each were selected, in order that, by checking the deductions separately obtained, all liability to error might be eliminated. One of these groups, giving the total fall of rain in each of the three years 1860, 1861, and 1862, is appended to this communication, and also a table of the monthly fall during 1862 at a few widely spread stations.

The very first question generally asked is, Was the fall above or below the average?—*apparently* a very simple question, but only apparently; for it hinges on, What *is* the average? It has hitherto generally been taken to be the arithmetical mean of the fall during as many years as observations have been made at the place. But this is by no means accurate; for, in the first place, there are not a large number of stations where observations have been continued long enough for this method to give satisfactory results. And if the period of observation be short (say, less than 20 years),

there is much danger arising from comparing 8 or 10 dry years at one place, with a series of wet years at another. Probably the method adopted by Mr. Eaton*, in his paper on the rain-fall of Devonshire, is the best; but even this method is hardly available where the points of observation are so distant from each other as are many of my stations.

When the collection of old observations has sufficiently advanced for the discussion of the returns to be commenced, steps will be taken to deduce the most probable mean for each station; but, until this can be done, I have adopted as a temporary standard the fall during the 10 years, 1850–59. This mean is about 5 per cent. too low; but, this correction being applied, the results may be supposed nearly correct.

Table III. gives the mean fall at 19 stations during the years 1850–59, and the difference of each of the three years 1860, 1861, and 1862 from this assumed mean fall.

The fall is therein shown to have been, in England, 9 inches *above* the average in 1860, 1½ inches *below* in 1861, and 2¾ inches *above* in 1862; so that the three years combined give a fall of about 8·48 inches above the mean of the previous 10 years. In Scotland the 3 years' mean is 5·91 inches; and in Ireland 7·78 inches above the same decennial period.

The rain-fall in London in 1862 was about 27 inches, being about 2 inches above the average of the last half-century; in the eastern counties there was not the average amount by about 3 inches, while in Devonshire and in the north-western counties it was much in excess. In the western counties of Scotland there was again a large increase. The enormously increased fall in the western counties of Scotland, and especially in the Isle of Skye and the Hebrides, during the last three years, almost seems incredible. The exact amounts at three or four of these stations are given in Table I., and show that, in the neighbourhood of Glasgow, the fall in 1862 was nearly half as much again as in 1860; that at Dunoon the fall in 1862 was 30 inches greater than in 1860; that at Portree there was an increase of 50 inches between 1860 and 1861, 1862 being less than 1861, but 23 inches greater than 1860; that in North Uist the fall in 1862 was 27 inches greater than in 1860; and finally that at Bernera, an island to the westward of the Isle of Lewis, the fall has been reported as being, in 1860, 32 inches; 1861, 61 inches; and in 1862, 105 inches.

* Proceedings of British Meteorological Society, vol. i. No. 1.

It only remains briefly to describe the manner in which the fall at a few stations has been laid down on the accompanying Map (Plate XIV.). The black and shaded circles have the place of observation for their common centre, and show, (1) by their relative magnitude, the variation in the fall in different parts of the kingdom; and (2) by the relative prevalence of exterior black or shaded rings, which of the two years, 1861 and 1862, had the heavier fall: for it must be borne in mind that the fall in two years is shown, 1861 by shaded circles, 1862 by black. The outer ring will, therefore, be black when the fall in 1862 exceeded 1861, and shaded when 1861 was in excess. For example, by reference to Table I. it will be seen that at Belfast the fall in 1862 was about 5 inches greater than in 1861; therefore the black disc, representing 1862, extends beyond the light disc, and produces the external black ring given in the Map.

Table I.—Annual Fall of Rain, 1860, 1861, and 1862.

England and Wales.

Counties.	Stations.	Height of rain-gauge above ground.	Height of rain-gauge above sea-level.	Depth of Rain. 1860.	Depth of Rain. 1861.	Depth of Rain. 1862.
		ft. in.	ft.	in.	in.	in.
Middlesex	Camden Town	0 4	100	32·24	22·34	27·57
Surrey	Cobham Lodge	0 6	110?	31·57	20·77	26·26
Kent	Tunbridge	0 0	125	31·43	23·11	27·62
Sussex	Chichester	0 6	20	37·44	25·15	27·47
Hampshire	Selborne	4 0	400?	42·05	30·40	33·12
Berkshire	Long Wittenham, Abingdon	1 0	170	30·69	22·67	29·79
Hertfordshire	Hemel Hempstead	3 0	250	34·22	21·20	27·44
Bedfordshire	Bedford	3 6	104	24·95	18·43	20·95
Essex	Epping	6 0	360	37·03	20·42	25·86
Norfolk	Burnham	4 6	102	34·65	24·78	26·71
Wiltshire	Alderbury, Salisbury	0 6	......	34·12	25·14	26·80
Dorsetshire	Bridport	0 11	95?	36·63	29·67	32·12
Devonshire	Goodamoor	0 2	580	72·02	53·66	63·14
Cornwall	Helston	5 0	110	42·96	37·62	38·43
Somersetshire	Taunton	1 3	50?	32·62	26·77	27·32
Gloucestershire	Gloucester	1 0	100	28·01	21·83	28·08
Warwickshire	Rugby	2 4	315	27·54	20·82	25·19
Lincolnshire	Boston	1 0	......	30·69	20·38	19·93
Nottinghamshire	East Retford	2 0	50	28·13	19·56	22·69
Derbyshire	Derby	5 0	179	32·77	22·01	26·28
Lancashire	Manchester	3 0	106	36·14	29·74	38·60
Lancashire	Stonyhurst	0 6	381	50·60	49·00	54·40
Lancashire	Wray Castle, Windermere	4 9	250	69·45	80·91	74·71
Yorkshire	Sheffield	0 4	337	37·19	29·68	40·06

TABLE I. (*continued.*)

ENGLAND AND WALES (*continued*).

Counties.	Stations.	Height of rain-gauge above ground.	Height of rain-gauge above sea-level.	Depth of Rain. 1860.	Depth of Rain. 1861.	Depth of Rain. 1862.
		ft. in.	ft.	in.	in.	in.
Yorkshire	Halifax (Well Head)	0 11	487	34·33	30·79	32·22
Yorkshire	Hull	3 10	11	31·74	19·97	23·70
Durham	Durham	1 0	338	30·33	24·28	21·82
Cumberland	Silloth	6 0	16	37·81	42·47	44·19
Westmoreland	The How, Troutbeck	1 8	403	102·58	116·26	94·27
Glamorgan	Ystalyfera, Swansea	4 0	368	73·21	66·78	67·07

SCOTLAND.

Counties.	Stations.	Above ground (ft. in.)	Above sea-level (ft.)	1860.	1861.	1862.
Wigtown	South Cairn, Stranraer	0 4	210	42·30	48·03	56·00
Dumfries	Dumfries	0 5	63	41·75	46·88	41·43
Berwick	Mungo's Walls, Dunse	0 4	267	29·87	28·37	28·80
Haddington	Thurston, Dunbar	3 0	320	34·10	25·80	30·40
Lanark	Baillieston, Glasgow	0 3	230	33·00	50·04	60·67
Ayr	Largs	0 6	30 ?	44·60	55·80	54·70
Renfrew	Greenock	0 6	64	59·25	69·14	74·25
Bute	Isle of Cumbrae	4 6	50	40·70	47·20	48·40
Argyll	Hafton, Dunoon	4 0	40	61·83	82·14	91·32
Perth	Glen Gyle	0 6	380	94·20	112·50	105·10
Perth	Scone Palace	2 6	80	28·75	31·13	34·46
Forfar	Dundee	0 3	230	32·66	28·90	33·09
Kincardine	Balnakettle, Fettercairn	0 3	450	42·81	44·58	37·73
Aberdeen	Aberdeen	0 4	100	34·70	30·97	30·77
Ross	Bernera, Isle of Lewis	0 6	15	32·37	60·91	104·95
Inverness	Loch Maddy, N. Uist	3 0	20 ?	42·65	60·40	69·45
Inverness	Portree, Isle of Skye	0 1	60	87·99	139·04	111·19
Sutherland	Dunrobin Castle	0 4	6	29·40	27·45	23·65
Orkney	Sandwick	2 0	78	37·96	41·18	34·38

IRELAND.

Counties.	Stations.	Above ground (ft. in.)	Above sea-level (ft.)	1860.	1861.	1862.
Waterford	Waterford	4 0	60	40·86	43·83	45·23
Waterford	Rathculliheen	1 6	135	37·56	38·79	41·21
Clare	Killaloe	5 0	128	48·76	51·84	47·37
Queen's Co.	Portarlington	9 0	245	34·84	36·70	45·16
Wicklow	Fassaroe, Bray	3 0?	250 ?	57·52	51·00	45·80
Dublin	Black Rock	28 0	96	26·70	24·67	24·98
Dublin	Monkstown	0 6	90	33·26	31·89	31·25
Sligo	Markree Castle	16 3	145	43·74	47·16	39·91
Down	Belfast	9 0	58	38·23	34·02	39·18

Table II.—Monthly Fall of Rain during 1862.

1862.	ENGLAND.						SCOTLAND.			IRELAND.		
	Castle House, Calne.	Banbury.	Barton, Bury St. Edmund's.	Hengoed, Oswestry.	Seathwaite, Cumberland.	Lilburn Tower, Alnwick.	Cargen, Kircudbright.	Easdale, Argyll.	Culloden House, Inverness.	Valentia, Kerry.	Galway.	Glasnevin, Dublin.
Height of Rain-gauge { above ground	0 ft. 11 in.	7 ft. 4 in.	1 ft. 0 in.	4 ft. 8 in.	1 ft. 0 in.	6 ft. 0 in.	0 ft. 3 in.	0 ft. 6 in.	3 ft. 0 in.	1 ft. 0 in.	6 ft. 0 in.	6 ft. 0 in.
„ sea-level	321 ft.	350 ft.	....	....	422 ft.	250 ft.?	80 ft.	25 ft.	104 ft.	50 ft.	25 ft.	65 ft.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
January	3.35	2.32	1.98	2.67	16.78	1.68	3.54	8.80	1.79	8.22	7.31	3.03
February	.47	.28	.34	.38	5.50	1.50	1.49	2.60	1.33	2.11	2.36	.57
March	4.90	4.22	2.43	3.76	10.30	3.88	3.41	2.90	1.48	4.86	3.94	2.99
April	3.02	1.88	1.66	2.92	17.26	1.40	3.92	2.50	.93	5.14	4.02	3.31
May	4.02	3.31	2.14	4.43	8.28	2.17	4.43	4.50	2.65	4.15	3.34	2.42
June	3.18	3.32	2.95	2.86	15.62	3.12	3.38	3.30	2.92	4.70	2.72	2.24
July	2.76	2.29	1.88	2.52	13.67	1.68	4.13	5.10	2.57	3.06	4.20	3.38
August	2.00	1.52	2.87	2.78	12.81	5.46	4.84	3.50	2.42	3.57	3.54	1.84
September	2.16	3.37	1.59	3.45	6.38	.68	2.47	2.10	1.27	3.33	2.68	2.24
October	4.66	2.73	3.05	4.40	32.13	5.86	7.96	10.40	2.65	10.03	6.68	2.71
November	.89	.74	1.23	1.43	5.14	.77	1.24	3.40	2.43	6.02	2.20	1.44
December	1.86	1.53	1.75	3.08	26.16	1.84	6.48	8.70	2.19	7.00	8.62	1.87
Total 1862	33.27	27.51	23.87	34.68	170.03	30.04	47.29	57.80	24.63	62.19	51.61	28.04
„ 1861	23.81	22.34	20.70	30.90	182.58	26.02	44.25	55.50	31.41	72.40	58.62	30.16
„ 1860	......	31.92	29.72	45.51	142.20	34.21	44.27	47.90	21.51	......	......	31.08

TABLE III.—Comparison of the Fall in each of the three years, 1860, 1861, and 1862, with the Mean of the Ten Years, 1850–1859.

Stations.	Mean fall 1850–59.	Departure from Mean.		
		1860.	1861.	1862.
	inches.	inches.	inches.	inches.
ENGLAND.				
Enfield, Middlesex	22·67	+11·90	− 2·65	+ 3·74
Chichester, Sussex	26·67	+10·77	− 1·52	+ 0·80
Banbury, Oxford	24·73	+ 6·83	− 2·64	+ 1·54
Holkham, Norfolk	26·13	+ 8·56	− 4·33	− 3·41
Goodamoor, Devonshire	54·12	+17·90	− 0·46	+ 9·02
Cirencester, Gloucestershire	29·60	+ 7·34	− 2·21	+ 2·86
Wigston, Leicestershire	26·39	+ 5·08	− 3·19	− 0·26
Preston, Lancashire	34·28	+ 5·48	+ 2·31	+10·05
Leeds, Yorkshire	20·91	+ 7·69	+ 2·39	+ 0·34
Seathwaite, Cumberland	126·98	+15·22	+55·60	+43·05
SCOTLAND.				
Thurston, Dunbar, Haddington	26·96	+ 7·14	− 1·16	+ 3·44
Largs, Ayr	43·06	+ 1·54	+12·74	+11·64
Castle Toward, Argyll	47·88	− 0·70	+17·46	+14·39
Hill Head, Dundee, Forfar	31·06	+ 6·37	+ 4·49	+ 6·27
Sandwick, Orkney	36·14	+ 1·82	+ 5·04	− 1·76
IRELAND.				
Portlaw, Waterford	39·49	+ 7·22	+ 9·82	+10·61
Black Rock, Dublin	21·78	+ 4·92	+ 2·89	+ 3·20
Killaloe, Clare	38·35	+10·41	+13·49	+ 9·02
Markree, Sligo	36·35	+ 7·39	+10·81	+ 3·56
ABSTRACT.				
England (Seathwaite omitted)	29·50	+ 9·06	− 1·37	+ 2·74
Scotland	37·02	+ 3·23	+ 7·71	+ 6·79
Ireland	33·99	+ 7·48	+ 9·25	+ 6·60
British Isles (all stations)	33·50	+ 6·59	+ 5·20	+ 5·38

XXIX. *On the Mean Annual Temperature of Western Europe, compared with other Climes.* By RICHARD ADIE, Esq., Liverpool. Communicated by JAMES GLAISHER, Esq., Sec.

IN the course of a long residence on the shores of the Mersey, I have noted the rapid changes in temperature which the sea-water there undergoes, varying from the lowest temperature to which salt water in its liquid state could be reduced, namely, 29° Fahr., on

February 23, 1855, up to 70°, recorded on August 3, 1856. This range of 51° is far beyond that which belongs to sea-water on British shores, and is occasioned by the extensive sand-banks connected with the estuary of the Mersey, which are twice in every twenty-four hours exposed to the sun and sky.

Seeing the powerful influence of these sands on a considerable body of sea-water which daily passes and repasses the town of Liverpool, I was led to reflect on the influence that a like condition, applied on the larger scale, might have on the climate of Western Europe. The sea-board of this part of the world is known to be favoured above all other climes, whether in the northern or the southern hemisphere, for its mean annual temperature. In the British Isles, there is a large area with a mean of 48° Fahr.; while, as we gather from the Chart published by the Medical Department of the Army of the United States, on the North American coast, the mean annual temperature of 50° crosses the Gulf-stream in latitude 42°. Again, in the registers published by the Royal Engineers of the British Army, the mean for St. John's, Newfoundland, Halifax, Nova Scotia, Quebec, Kingston, Canada, is 3° Fahr. below the British rate, although the latitude of these stations is from 8° to 10° south of the places in Britain with which they are compared.

In the year 1850, I communicated a paper* to show that the Gulf-stream did not appear to me to be adequate to account for so great an advance in temperature; and I there ventured to suggest that the extensive area of Africa, north of the equator, might tend greatly to elevate the temperature of the European climate.

I believe it to be admitted that the intense heats of some winds in Spain and Italy are derived from the African Sahara; but, beyond that, I think men of science consider that the Gulf-stream, spreading out on the Atlantic after it leaves the Newfoundland Banks, is the great source of Europe's favoured climate.

Since the date of the publication above referred to, the volumes published by the Army Departments in Britain and the United States throw some additional light on this subject, which I shall be glad to give for consideration. For example, a parallel of latitude which is common to the Gulf-stream and the Mediterranean Sea has the same mean annual temperature.

The registers of the Royal Engineers, for their principal stations in the northern and southern hemisphere, show the former to be at least 4½° the warmer.

* Edinburgh Philosophical Magazine, vol. xlix. p. 236.

The mean latitude and temperature of the three stations, Gibraltar, Malta, Bermuda, is north latitude 34° 49′, temp. 66°·8.

For the three stations, Auckland, New Zealand; Graham Town, Africa*; and Freemantle, West Australia: south latitude 34° 4′, temp. 62°.

Another proof of the relatively higher temperatures of the northern hemisphere is given by the trade-winds in the Atlantic. In that ocean, the N.E. trade never reaches up to the equator, while the S.E. trade crosses it, and at some seasons attains to 8° of north latitude, showing that there the equator for temperature is near 5° north latitude.

The explanation of the higher temperature found in the temperate zone of the north, as compared with the south, appears to me to be due to the larger proportion of dry land; for the soil of all temperate zones throws off large quantities of fresh water to the sea, which reaches the land in the state of aqueous vapour, and there parts with the caloric of elasticity. The late Professor Daniell, in his 'Meteorological Essays,' adverted to the water given by dry land to the sea, as a gauge of the preponderance of rain- and dew-falls over evaporation. A friend of mine has a series of experiments on the evaporation from the two equal pans of a balance. When water was compared against moist earth, the porous surface of the earth evaporated most. When a moist grass-turf was exchanged for earth, then it depended on the state of the weather, which of the two pans lost the most weight. In Western Europe, the prevailing winds are from the sea; so that the aqueous vapour carried inland must exceed what is carried out to the Atlantic. I consider, then, that the safest guide to show that the dry land receives caloric from the atmosphere of the sea is the fresh water discharged from the land. The Rain-chart of the Medical Department of the United States Army gives another proof of the aqueous vapour from the ocean elevating the temperature. The isothermal lines in this chart, traced across the North American continent, tend much to the southward in the central basin, where the rainfall is set down at one-fifth of the quantity that falls on the coast.

It is only in the temperate zone that a greater proportion of land over water is found to belong to the northern hemisphere. Within the Arctic and Antartic circles, the proportion of land is probably in excess in the south; but this is at present unknown, although the proportion of land to water may have much to do

* Reduced to sea-level.

with the polar currents which these regions send out. Within the Arctic circle the surface is for so great a portion of the year covered with frozen water that, whether it be sea or land, the effect on the atmosphere cannot be very different.

Within the tropics, where the sun's relative power on soil or sea is the greatest, the balance between land and water on the two sides of the equator is nearly equally adjusted. I examined the surface of a three-feet globe, for the proportion of land to water, by a series of triangles over the dry-land surfaces put down within the tropics; and the result was, that land occupied one-fourth of the area, being pretty equally distributed between north and south latitude.

In the two years' registers for Corfu, given by the Royal Engineers, the mean annual temperature corresponds with a position of the isothermals on the Gulf-stream of 36° 30′, or 3° of latitude further south than Corfu; while Malta and Gibraltar agree nearly in temperature with the isothermal on the Gulf-stream in a similar latitude. These localities, on opposite sides of the Atlantic, are known to be each of them in proximity with two unwonted supplies of heat, which I believe will be granted to elevate their temperature. To their joint action my communication above referred to attributed the mild climate of Europe; and to Africa, the source of heat nearest at hand, I gave the first place, which the high rate for Corfu, in so far as it goes, would seem to confirm. Graham Town, in South Africa, and Corfu, when corrected for the sea-level, have nearly the same mean annual temperature, with a difference of 6° in their latitudes, the southern station being nearest the equator. Again, Gibraltar is 5½° Fahr. above a similar latitude in New Zealand.

The mean annual temperature of Britain is equal to insular situations, in other parts of the world, with 12° to 15° lower latitude; and, as a practical proof of the climate, I may mention that between latitude 56° and 58°, in open winters, snowdrops bloom in January. On the south side of the Alps, I have no doubt that they will do so likewise; but to the north of that mountain-chain, there are many fertile lands which must tarry some weeks before the snowdrop appears.

XXX. *On the Effect of Light upon Ozone Paper.* By JOHN ATKINSON, Esq. Communicated by JAMES GLAISHER, Esq.

IN the early part of August last, I had just begun a series of experiments to ascertain the amount of ozone indicated when the paper (Dr. Moffatt's) was placed in an "ozone-box," constructed so as to admit air, but to exclude the light, as compared with the amount indicated when the paper was placed in my thermometer-stand, and simply shielded from the direct rays of the sun. I continued these experiments through the month of August (with an interruption of about two days) and up to the 24th of September.

Very pressing engagements have prevented me till now from tabulating these experiments and sending the result. Herewith I have the honour to forward two Tables, one extending from July 30 to August 31, with a break of two and a half days; and the other including the observations made in the first twenty-four days of September, after which they were discontinued.

The first two columns of these Tables contain the result of the observations at 9 A.M. and 9 P.M., by means of ozone paper placed in the "ozone-box." The next two give the observations made upon paper placed in the thermometer-stand; and the two succeeding columns give the direction and force of the wind at the time of observation. The two last columns show the sum of the numbers representing the amount of colour developed *each entire day* IN or OUT of the box.

It may be well to mention that, in making these experiments, one ozone paper was, in each instance, cut in two, and one of the halves placed in the ozone-box and the other in the thermometer-stand, at about 4 feet from the ground. After twelve hours' exposure in this way, the pieces were joined, and the amount of colour on each half carefully estimated by the scale.

The two Tables were made, as I may say, independently of one another; for when the average was obtained in the first Table, curiosity prompted me to see what analogy the results in September would bear to those for August. So I proceeded to write out the numbers from the ozone papers for September; but I found that after the 24th the papers had not been cut, and that the experiments had been suspended. Hence I was obliged to be satisfied with the first twenty-four days of September for making my comparison with the results obtained in August.

Table I. gives the average amount of ozone for twenty-four hours, *in* the *box*, 4·2, and, in the stand, 10. These results are in the proportion of 168 : 400, or of 42 : 100. Table II. shows the corresponding results to be in the proportion of 168 : 399, or almost precisely the same as in Table I., thus proving that 58 per cent. of the amount of ozone in the air was left undetected when the paper was placed in the box which I had used. I determined, therefore, to abandon the use of the box, and in future to place the paper in the thermometer-stand, where it is protected from the direct rays of the sun and from the rain. This determination, I may state, was formed at the latter end of September, and before I had made an exact numerical estimate of the amount of ozone lost by having the papers placed in the box.

I concluded from these experiments that my perforated box did not allow of a sufficiently free circulation of air about the ozone paper, and hence that the real amount of ozone present was not made known.

The object in registering the direction and force of the wind in this investigation was to endeavour to trace the connexion, if any, that might exist between the amount and *quality*, as it were, of air brought into contact with the paper, and the intensity of the colour developed. No satisfactory or clear result was arrived at on this point. But it must be owned that the means adopted for ascertaining the sum of the moments (*i. e.* the time multiplied into the intensity of the breeze) of the wind were so rude and inadequate that the experiments cannot be said to decide anything *pro* or *con* on the question started. The subject deserves a renewed and careful treatment, which I may perhaps attempt at some future time.

Table I.

1862.	Moffatt's paper in box.		Moffatt's paper in thermometer-stand.		Direction and Force of the Wind.		In box.	In stand.
	9 A.M.	9 P.M.	9 A.M.	9 P.M.	9 A.M.	9 P.M.	Total Ozone.	Total Ozone.
July 30	0	2	1	4	W. 0	W. 2	2	5
„ 31	4	4	10	10	S.W. 3	S.W. 2	8	20
August 1	4	3	10	8	S.W. 2	W. 2	7	18
„ 2	*	3	*	6	* *	W. 2	3	6
„ 5	4	3	10	8	S. 2	S. 3	7	18
„ 6	3	4	8	7	S.W. 2	W. 3	7	15
„ 7	4	5	10	8	N.E. 1	W. 2	9	18
„ 8	5	1	8	2	W. 3	W. 1	6	10
„ 9	3	3	6	3	N. 2	W. 2	6	9
„ 10	4	2	10	4	W. 2	W. 2	6	14
„ 11	4	2	8	4	N.W. 1	W. 1	6	12
„ 12	1	3	4	5	S.W. 1	S.W. 1	4	9
„ 13	4	2	10	6	S.W. 0	S.W. 0	6	16
„ 14	1	1	5	6	S.W. 0	W. 1	2	11
„ 15	0	0	0	0	N. 0	N.W. 0	0	0
„ 16	0	0	0	2	N.E. 1	N.E. 1	0	2
„ 17	0	3	1	8	N. 1	N.E. 1	3	9
„ 18	0	2	4	5	N.W. 1	W. 1	2	9
„ 19	1	0	3	1	S. 1	S. 2	1	4
„ 20	1	1	3	3	E. 3	S. 0	2	6
„ 21	0	1	1	5	S. 0	N.W. 1	1	6
„ 22	2	0	5	3	N.W. 1	N.W. 3	2	8
„ 23	2	1	4	6	W. 2	N.W. 2	3	10
„ 24	0	2	1	6	S.W. 0	N.W. 1	2	7
„ 25	2	4	5	5	S. 2	S.E. 2	6	10
„ 26	3	4	8	4	S.E. 1	E. 2	7	12
„ 27	3	4	8	8	S.E. 1	S. 1	7	16
„ 28	0	3	0	7	N. 1	N.W. 2	3	7
„ 29	0	4	0	6	N.E. 0	E. 0	4	6
„ 30	1	2	3	6	E. 1	S. 0	3	9
„ 31	1	4	4	6	E. 0	N.E. 0	5	10
						Totals	130	312
						Average per day	4·2	10

That is, 168 : 400 = 42 : 100.

TABLE II.

1862.	Paper in the box.		Paper in the thermometer-stand.		Direction and Force of the Wind.		In box.	In stand.
	9 A.M.	9 P.M.	9 A.M.	9 P.M.	9 A.M.	9 P.M.	Total Ozone.	Total Ozone.
September 1...	0	0	1	1	N. 0	N. 0	0	2
" 2...	0	3	1	6	N.E. 0	W. 0	3	7
" 3...	1	2	2	7	S.W. 0	S.W. 1	3	9
" 4...	2	3	10	8	S.W. 2	N.W. 2	5	18
" 5...	1	1	1	1	N.E. 1	N. 0	2	2
" 6...	1	2	2	7	N. 0	W. 0	3	9
" 7...	0	3	1	9	S.W. 0	N.W. 0	3	10
" 8...	0	1	1	4	S.W. 1	N.W. 0	1	5
" 9...	1	1	2	3	S. 0	N.W. 0	2	5
" 10...	0	2	0	6	N.W. 1	N.W. 0	2	6
" 11...	0	2	0	5	W. 0	S.W. 0	2	5
" 12...	0	1	0	4	S. 2	S. 1	1	4
" 13...	3	5	8	10	S. 2	S. 4	8	18
" 14...	3	1	9	4	N. 1	N.E. 1	4	13
" 15...	1	0	3	1	E. 2	E. 0	1	4
" 16...	0	0	0	1	E. 0	N.E. 0	0	1
" 17...	0	1	0	5	E. 0	N.E. 1	1	5
" 18...	0	3	1	7	S.E. 0	S.E. 1	3	8
" 19...	0	4	0	6	S.E. 0	S.E. 0	4	6
" 20...	1	2	2	4	E. 0	N.E. 0	3	6
" 21...	1	3	2	6	E. 0	N.E. 2	4	8
" 22...	2	5	4	7	E. 1	S.E. 2	7	11
" 23...	1	6	1	8	E. 1	S.E. 2	7	9
" 24...	3	5	6	6	S.E. 2	S.E. 1	8	12
					Totals		77	183
					Average per day........... ...		3·2	7·6

That is, 168 : 399.

BOOKS AND NOTICES.

XV. *Dalton's Theory of Vapour, and its Application to the Aqueous Vapour of the Atmosphere.* (*Extract of a Letter from* Professor LAMONT *to* Professor KÄMTZ *at Dorpat, dated Munich, August* 28, 1862.) (From Phil. Mag. 1862, Nov.)

[Reprinted from the 'Philosophical Magazine' by permission of the Editor.]

Royal Observatory, Greenwich,
October 11, 1862.

GENTLEMEN,—The paper, of which I enclose a translation, has been circulated in a printed form by Dr. Lamont. The importance of the subject in reference to all meteorological inquiries,

especially to those on the broad scale, may, I trust, be accepted as my excuse for submitting it for publication in the 'Philosophical Magazine.'

As far as observations have enabled me to form an opinion, I assent entirely to the views of Dr. Lamont.

For the translation itself, I am indebted to the friendly assistance of W. T. Lynn, Esq., Assistant of the Royal Observatory.

I am, Gentlemen,
Your obedient Servant,
G. B. Airy.

To the Editors of the Philosophical Magazine and Journal.

You will, I believe, agree with me in this, that we are now arrived at that point in meteorology where it is absolutely necessary to come to a definite decision as to what is the relation in which the aqueous vapour existing in the atmosphere stands to the atmosphere itself. Does the aqueous vapour form an atmosphere itself independent of the air, or is it merely mechanically mixed with the air, so as only, as a gas standing in no chemical relation to the air, to increase the volume and the weight of the atmosphere?

Of the many important questions which have reference to the variations of the barometer, none can be thoroughly investigated without first coming to a clear understanding of this. At the same time the matter here in hand is an important problem of general physics, in regard to which also the mutual relations of air and vapour have hitherto been by no means ascertained with the necessary certainty. An investigation which I have instituted in this direction has now, it appears to me, led to a decisive result; and I believe that I ought so much the more to make communication to you upon it, as the result obtained is contradictory to the generally prevailing views of physical philosophers and meteorologists, and leads to the necessity of in part supplanting the principles which have hitherto had universal acceptance, in regard to aqueous vapour, by new ones.

On account of the connexion, it will be in the first place necessary that I should notice the progress of the development of the theory of aqueous vapour.

We have to consider Dalton as the originator of the theory of the action of aqueous vapour, he having instituted experiments so comprehensive and well contrived that nothing of importance has been added by the labours of later investigators. An accurate survey of Dalton's experiments will enable us to deduce from them the following principal results:—

(1) In space destitute of air, the evaporation of water goes on only until the vapour has attained a determinate expansive force, dependent on the temperature; so that in every space void of air which is saturated with vapour, a determinate vapour-pressure corresponds to a determinate temperature.

(2) In space filled with air, the same amount of water evapo-

rates as in space destitute of air; and precisely the same relation subsists between the temperature and the expansive force, whether the space contains air or not.

(3) The evaporation of water goes on rapidly in space void of air, but very slowly in space filled with air in a state of quiescence; and even when it is assisted by a tolerably brisk motion of the air, a considerable time is notwithstanding always required.

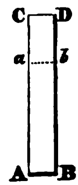
In this way are the development and extent of aqueous vapour in space void of air and space filled with air determined by means of Dalton's experiments: as to the mutual relations subsisting between vapour and air, when they are simultaneously present in the same space, the experiments afford no information; and this deficiency Dalton supplied by giving to the second of the above-quoted propositions such an interpretation as if no mutual relation whatever existed between vapour and air, and as if they remained near each other without producing any the slightest mechanical effect upon one another. It is strange that physical philosophers have in general inconsiderately accepted this theory, so important and so pregnant with consequences, without remarking that it constitutes only a possible, but not a necessary result of the experiments. Not less singular is it that meteorologists have treated Dalton's theory as available for application to the aqueous vapour of the atmosphere, and have supposed an atmosphere of vapour to exist independent of the air, and sustained in equilibrium by itself alone, notwithstanding that the third of the above propositions properly declares that there is indeed always a tendency to a normal relation, which is conceived to be in the state of restoration, but which is never reached, because, in consequence of the changes constantly taking place, the requisite time to produce an equalization is never afforded.

Objections have from time to time been brought forward to the existence of an atmosphere of vapour independently subsisting. Bessel has (Ast. Nach. No. 236) adduced the consideration that in such a vapour-atmosphere the expansive force of the strata incumbent upon one another must diminish according to a determinate proportion, but that, from different observations, it may be concluded that this proportion does not really exist; his arguments, however, appear—principally, perhaps, owing to the want of sufficient data from observation—to have produced no impression; nor was more notice taken of the experiments of Broun in Makerstoun (Report to Sir T. Brisbane) and Jelinek in Prague (Denkschriften der Wiener Akad. math.-naturw. Classe, vol. ii.), who proved by experiments that in different localities situated very near together, where the same reading of the barometer is observed, a very different vapour-pressure may be indicated. One of the most zealous opponents of Dalton's theory was Espy, who (especially in his second Report on Meteorology) exposed its defects with much penetration, without, however, furnishing a precise refutation. I believe that I have myself brought forward the first proof of the incorrectness of the theory (Denkschriften der Münchner Akad. math.-phys. Classe, vol. viii.), in the year

1857, when I showed, by means of observations extending through many years, that in a small vapour-pressure the mean reading of the barometer stands quite as high as in a great vapour-pressure; at the same time I contrived an easily-performed experiment, in which, contradictory to Dalton's theory, a mass of vapour and a mass of air, placed in communication with each other, mutually preserve a state of equilibrium without the vapour penetrating into the air or the air into the vapour. As the result of this, I laid down the proposition that the vapour exerts a pressure upon the air and the air upon the vapour; and the atmosphere is to be regarded as a mixture of masses of air, some more and some less humid. Strachey furnished a second very solid proof of the inadmissibility of Dalton's theory in a paper which he read before the Royal Society of London in the year 1861. Proceeding upon considerations which are fundamentally identical with those developed by Bessel, he gave a collection of the results of observations which had been obtained upon high mountains and in air-balloon expeditions, and showed that they were incompatible with the supposition of an independently-subsisting atmosphere of vapour. To instance one point only, it may be here mentioned that the observations of Welsh, who ascended in a balloon to the height of 23,000 feet, place us in a position to calculate the pressure which the vapour contained in the atmosphere would exert on the earth's surface; but the value determined in this manner amounts only to the fourth part of the pressure actually assigned by the psychrometer. It might have been supposed, from the clearness of the proofs adduced and the close agreement of all the results of observation, that a finally satisfactory decision would have been arrived at; nevertheless we find, even in the most recent times, that the "pressure of the dry air" and the "pressure of the vapour-atmosphere" are, as before, kept distinct the one from the other. There is, I believe, no other means of removing the rooted ideas in consequence of which "*Dalton's laws*" are constantly appealed to, than the direct proof that *Dalton's laws themselves contain an essential error*.

With this view I undertook a short time since the series of experiments to which I referred at the outset. I first convinced myself how extremely slowly the vapour in the air spreads itself from one part of space to another, if, without destroying the communication between them, the free circulation of the air be restrained. It is mainly the circulation of the air that carries off the vapour from the evaporating surface, and conveys the vapour, when already diffused, to the chloride of calcium to be absorbed; one would almost believe that the individual molecules of air must come to the surface of the water to take thence the moisture, and to the chloride of calcium to give up to it the moisture; the expansive force of the vapour itself is in every case a matter of small influence on its diffusion in the air. Now, if we take a closed tube, A B C D, fig. 1, filled with air, and introduce a small

Fig. 1.



quantity of water through an aperture near A, which is afterwards immediately closed, into the bottom A B of the tube, the water begins gradually to evaporate, and the vapour ascends, after the expiration of a certain time, up to *a b*. How then will the pressure be distributed upon the interior sides of the tube?

If, as I have endeavoured to prove by means of the above-mentioned experiment, the vapour and the air exert a mutual pressure upon one another, the expansive forces of the air and of the vapour will act together in such a manner that an amount equal to *their sum* will press upon all points of the interior wall; and if we take separately the pressure peculiar to the vapour alone, it is precisely as great as if the mass of vapour was uniformly distributed in the whole space A B C D. A totally different state of things will result if the view set up by Dalton, and generally accepted by philosophers, is well founded; for as, according to this view, the vapour diffuses itself in the interstices of the molecules of air, *without producing any mechanical effect whatever upon the molecules themselves*, no pressure at all can be produced upon the interior side of the tube by the expansive force of the vapour, under the circumstances indicated above; and no pressure takes place until the vapour reaches the upper surface C D.

The state of things here indicated is only a *transitory* one; a similar state may, however, be made *permanent* by maintaining in the lower space A B *a b* a higher, and in the upper space *a b* C D a lower temperature. If we denote the lower space by V, the upper by V′, the lower temperature by t, the higher by t', and the corresponding expansive forces of the vapour by $f(t)$ and $f(t')$; also the expansive forces of the enclosed masses of air by $k(1+at)$ and $k(1+at')$, we have, according to the hypothesis advocated by me, the expansive force of the mixture

$$=\frac{V}{V+V'}[k(1+at)+f(t)]+\frac{V'}{V+V'}[k(1+at')+f(t')]$$

$$=k+\frac{ka}{V+V'}(Vt+V't')+\frac{1}{V+V'}\big(Vf(t)+V'f(t')\big),$$

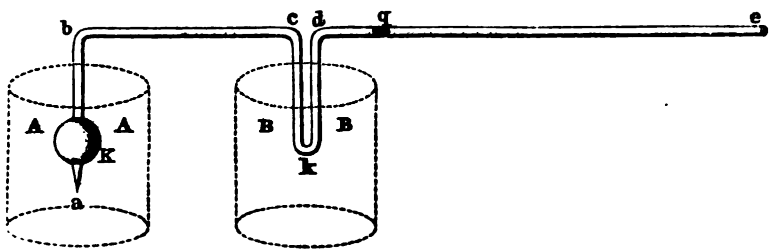
whereas, according to Dalton's theory, the expansive force will only amount to

$$k+\frac{ka}{V+V'}(Vt+V't')+f(t'),$$

while the vapour passing into the space *a b* C D with the force $f(t)-f(t')$ must be immediately condensed. Thence it immediately follows that, if the temperature t' of the upper space continues constant while the temperature of the lower space gradually increases, the pressure upon the upper surface C D is increased, according to Dalton's theory, only by the expansion of the air, but not by the newly-forming vapour itself, whereas, according to my hypothesis, besides the effect which is produced by the expansion of the air, a very considerable augmentation of the

pressure arises from the newly-formed vapour. As the conditions here indicated admit of being practically placed in operation, we have a simple and certain means of coming to a decision regarding the correctness of Dalton's theory; and the only thing requisite is to arrange an appropriate contrivance for the experiment. I have selected the following: A glass tube bent in the form represented in fig. 2 was provided, at one end with a globe K, whilst the other end *e* was left open; in the straight part *d e*, it was made to contain a drop of quicksilver, *q*. The curved part *c k d* of the tube was plunged into a vessel, B B, filled with cold water; into the vessel A A, where the globe K was placed, cold and warm

Fig. 2.



water could in turn be poured. The globe K was first filled with dry air; and the experiment showed that if the temperature was increased from 67°·3 to 126°·0, the drop of quicksilver moved forwards by 12·224 inches.

During this experiment, a thermometer placed in the vessel B B stood at 59°·0. Afterwards the globe was opened by breaking off the fine point *a*, some water introduced, and the point again joined on by melting. Again cold and warm water were poured into the vessel A A whilst the temperature of the tube remained unaltered, by which means, according to the theory of Dalton, a rise of temperature from 67°·3 to 126°·0 would, if the vapour had not penetrated in the tube up to the drop of quicksilver, move the latter as before 12·224 inches, and if the vapour had so penetrated, at the most $\frac{1}{58}$th further; instead of which, the motion actually produced amounted to nearly the double of this. It resulted from accurate measurement, that the 12·224 inches were passed over as soon as the temperature had been raised from 67°·3 to 101°·5.

A second glass tube was employed of a similar form, but with a smaller globe; and with this, as long as there was only dry air in the globe, an increase of temperature of from 64°·4 to 131°·5 occasioned in the drop of quicksilver a motion of 13·706 inches; but after a small quantity of water had been introduced into the globe, the quicksilver moved the same distance when the temperature was raised only from 64°·4 to 102°·0. As it might be imagined that it was possible that, after a longer interval of time, the vapour would extend up to the drop of quicksilver and then produce a

different result, the globe was left for a whole hour in warm water, but the position of the quicksilver remained unchanged.

Also, after the termination of the experiment, neither in the first nor in the second tube could a trace be perceived of the vapour having passed down into the bent part between *c* and *d*; so that it probably penetrated into the tubes either not at all or only to a small extent. On this supposition the observed effect would require the conclusion that the increase in the expansive force of the dry air in a change of temperature from 67°·3 to 126°·0 is precisely as great as the increase in the expansive force of the air and the aqueous vapour in a change of temperature from 67°·3 to 101°·5; and this also agrees exactly, for the former increase is calculated to be 0·119, and the latter amounts to—

For the air	0·070
For the vapour........	0·048
Therefore, together ..	0·118

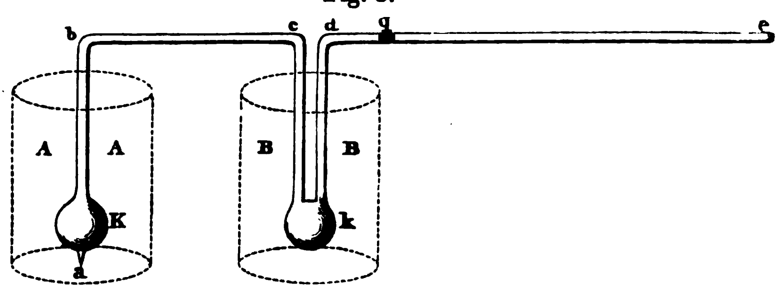
In the second experiment we have the increase of the expansive force

For dry air, from 64°·4 to 131°·5	0·136
Then	
For air, from 64°·4 to 102°·0	0·076
For vapour, from 64°·4 to 102°·0	0·052
Therefore, together	0·128

little differing from the preceding number.

In order to obtain still greater certainty, I modified the experiment in the following manner:—I gave the glass tube the form represented in fig 3, which differs from the form previously used

Fig. 3.



in this particular, that at *k* a globe is attached of about the same size as the globe K; moreover the vessel B B was filled with pounded ice and water, so that the temperature was constantly maintained at 32°·5. The results were as follows:—

(1) When the tube was filled with dry air, the drop of quicksilver moved, during a rise of temperature from 60°·6 to 142°·7 a distance of 12·128 inches.

(2) When some water was introduced into the globe K, the quicksilver moved the same distance of 12·128 inches during a rise of temperature of only from 60°·6 to 111°·4.

If we calculate in the same manner as above the increase of expansive force, we obtain—

For dry air with a rise of temperature from 60°·6 to 142°·7 .... 0·174
For air and vapour together, with a rise of temperature from 60°·6 to 111°·4, separately,
For air .... 0·103
For vapour .... 0·082

Together .... 0·185

This result is somewhat greater than that obtained for dry air; ground is therefore afforded for conjecturing that some vapour must have passed from the globe K towards *k*; the quantity, however, can only have been very small; for when the vessel A A contained water of constant temperature (61°·3) and cold and warm water alternately were introduced into the vessel B B, in order to move the quicksilver 8·313 inches a rise of temperature was requisite as follows:—

Before the above experiments .... from 62°·4 to 137°·7
After the above experiments ...... from 62°·4 to 135°·0

and afterwards, when the globe K had stood for two hours together in water at a temperature from 110°·8 to 122°·0,
from 62°·4 to 132°·4.

From the latter determination it is to be inferred that, notwithstanding a considerable vapour-pressure was maintained for so long a time in the globe K, yet not so much vapour had passed into the globe *k* as would have been requisite for the saturation of the space at a temperature of 32°·0, although the aperture of the tube had a diameter of 0·097 inch.

We are incontestably entitled to conclude from these experiments that Dalton's theory, in so far as it assumes that the air and the vapour existing in the same space are independent of each other, is totally unfounded; the true view rather is that *the air exerts a pressure upon the vapour and the vapour upon the air*. I make use here of this mode of expression merely in order to represent the effect. I hope at a future opportunity to be able to show that the humidity must be regarded as adhering to the molecules of air, and that the phenomena admit of a simple explanation by means of a natural hypothesis concerning the expansion of dry and wet molecules of air.

If it be desired to apply the theory developed in the foregoing to the circumstances of the aqueous vapour in the atmosphere, it is in the first place to be inferred from it that (since the diffusion of the vapour in the air takes place but very slowly, and since in different places, according to the temperature and the magnitude

the fact of the grapnel having been exposed to a temperature of zero, incautiously took hold of it with his naked hands, and cried out, as in pain, that he was scalded, and he called on me to assist him to drop it. The sensation was exactly that of scalding water.

The blackness creeping over the land at sunset was very remarkable, while the sun was still shining upon us. The general results of this ascent confirm in a very remarkable degree those obtained from the preceding experiments, and indicate that very few more extreme high ascents will be necessary for this purpose.

I cannot close this account without again expressing my sense of the great skill and judgment of Mr. Coxwell. The circumstances of this ascent were peculiar. Leaving the earth early in the season, with a cold east wind, to pass high up into colder regions, he never for an instant, from leaving the earth to returning to it, took his eye off the balloon, except when otherwise engaged in its management; indeed he was so completely occupied that he was unable to make a single note. The balloon descended at Barking Side, near Stratford, at half-past six o'clock. James Glaisher.—*From the Times, April* 3, 1863.

Note.—I was in the Telegraph Office, at the London Bridge Terminus, during the afternoon of March 31. My attention was directed to Mr. Coxwell's balloon at 5 P.M. The weather was clear and brilliant in the extreme—one of the many bright days with which we have been favoured during the month of March. The balloon, which I watched from 5^h to $5^h\ 30^m$, had the appearance of a golden globe, gently floating far up aloft—the face upon which the sun was shining being directed towards the place where I was standing. Several sand-bags were emptied of their contents during the time I was watching the floating globe. The appearance of the sand was remarkable. It was lighted up by the sun as it fell, and presented itself to the eye as a long silver streamer, hanging pendent beneath the balloon, in most cases nearly vertical, but in some instances with the lower end lagging a little in rear of the balloon. The silver line did not part company with the golden globe on the instant, and become dispersed in the air, but remained for some sensible time as part and parcel of the floating ball.—C. V. W.

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7. *On the nature of the Forces producing the greater Magnetic Disturbances.*—Mr. Balfour Stewart, F.R.S., Manager of the Kew Observatory of the British Association, delivered a Lecture on the above important question at the Royal Institution on the evening of Friday, March 20. He regarded the earth as the iron core of an electro-magnet, excited by some primary current (probably in the sun), and having a conductor round it in the upper and moist crust of the earth, and another conductor in the upper and rarer strata of the atmosphere, with an insulating medium in the lower and denser strata. He considers that every time a small and rapid change takes place in the magnetism of the earth, it gives rise to a secondary or induced current in the two conductors; and that this occasions earth-currents in the lower, and auroras in the upper conductor. An abstract of this paper shall appear in a future number of the 'Proceedings.'

NOTICE TO MEMBERS.

No. 7 of the 'Proceedings' is in the press, and will in a few days be distributed to Members. It contains the papers read at the Meeting on March 18, and other matters.

The four Numbers of the 'Proceedings' published for the last Session are to be obtained from Messrs. Taylor and Francis, for Nine Shillings.

Members are requested to forward Notes and Notices for insertion in the 'Proceedings' to one of the Secretaries.

[*Price Two Shillings.*]

Vol. I.] [No. 7.

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

1863, MARCH 18.

CONTENTS.

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BRITISH METEOROLOGICAL SOCIETY.

THIS Society was established in the year 1850, for the encouragement and promotion of Meteorological Science.

It consists of Members and Honorary Members.

Every person desirous of admission into the Society must be recommended by at least Three Members, of whom one must certify to his personal knowledge of such Candidate.

Candidates may be proposed at a Council Meeting; but the ballot must take place at an Ordinary Meeting. One Council or Ordinary Meeting must intervene between the nomination and the day of Election.

There is no Admission Fee. The Annual Contribution is £1; due on January 1. The Composition Fee is £10.

Persons eminent in Meteorological Science, not permanently residing in this country, are eligible as Honorary Members.

The Council of the Institution of Civil Engineers allow the Society to hold their Meetings at the Institution, No. 25 Great George Street, Westminster, S.W.; and to receive letters there.

Four Ordinary Meetings are held during the Session, which commences in October and terminates in June, at which Members can introduce their friends.

Papers accepted for reading at the Ordinary Meetings are published entire or in Abstract in the 'Proceedings' of the Society, which are issued as soon as possible after each Meeting, *and of which a copy is sent to every Member of the Society*. The 'Proceedings' also contain Notices of Books and Memoirs, descriptions of New Instruments, and other Meteorological News.

Daily observations are made, for the most part by Members of the Society, at about 60 different stations, which are forwarded monthly to one of the Secretaries, by whom each reading is examined and collated with readings made in adjacent stations. Their means are taken; and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of each 'Quarterly Meteorological Report' *is sent free to every Member of the Society*.

Copies of printed results of Meteorological Observations or Papers are from time to time received by the Society for distribution; and *are forwarded free to Members*.

The 'Proceedings' of the Society are published and sold by Taylor and Francis, Red Lion Court, Fleet Street, E.C.

The Society possess a Library, which is available to Members. The President, N. Beardmore, Esq., has kindly received it in his rooms, 30 Great George Street.

The address of the Treasurer, H. Perigal, Esq., to whom subscriptions may be paid, is 57 Warren Street, Fitzroy Square, W.

1863, January 1.

JAMES GLAISHER, F.R.S., Dartmouth Place, Blackheath, S.E.
CHARLES V. WALKER, F.R.S., Fernside, Redhill.
} *Secretaries.*

PROCEEDINGS

OF THE

BRITISH METEOROLOGICAL SOCIETY.

Vol. I.] 1863, MARCH 18. [No. 7.

ROBERT DUNDAS THOMSON, Esq., M.D., F.R.S. L. & E.,
Vice-President, in the Chair.

The Rev. J. Chadwick Bates, M.A., Queen's College, Oxford, Incumbent of Castleton Moor, near Manchester;
H. Billson, Esq., Hotel Street, Leicester;
Richard Whitfred Hewlett, Esq., M.B. Lond., M.R.C.S.E. & R.C.P.E., Harrow-on-Hill, N.W., and 10 Maddox Street, Regent Street, W.;
Thomas Hewlett, Esq., F.R.C.S., Harrow-on-Hill, N.W.;
Samuel Unwick Jones, Esq., 4 Upper Parade, Leamington;
Abraham Pope, jun., Esq., 81 Edgware Road, W.;
T. Pratt, Esq., 228 Hackney Road, N.E.;
Thomas Read, Esq., 66 Torrington Square, W.C.;
William Henry Yates, Esq., Staff Assistant-Surgeon, Army Medical Department, 6 Whitehall Yard, S.W.;
were balloted for and duly elected Members of the Society.

XXXI. *On the Winter which occurs in the Spring of the Year; and the Summer which occurs in the Fall of the Year.* By John Charlton Bloxam, Esq.

Authority concurs with popular belief in asserting that the spring season includes a secondary winter, and that the autumn season includes a secondary summer. But are these reputed

occurrences matter of fact? and if they be, what are the characteristics of these unseasonable seasons? And further, how shall we proceed, with a view to detecting the real facts of the case? There can be no doubt of the fact that we do every year suffer under what is called the "blackthorn winter" in April, and that we habitually suffer or experience the so-called "St. Martin's summer" in November. Nevertheless, it is problematical whether a decline of temperature or a cessation of augmenting temperature occurs in the first-named season, also whether an increase of temperature or a cessation of declining temperature occurs in the other season.

These questions can only be solved by the evidence of clear facts; and the facts must be derived from many years of observation, because those belonging to any one year may be altogether exceptional. But a multiplication of facts all bearing on the same point, and each in itself entitled to be considered correct as much as either of the others, but nevertheless varying greatly and irregularly in their respective values, may become a perplexing and unmanageable mass, unless they be consolidated so that equivalent units may be eliminated from multiform multitudes, and then stand in uniform order. This, if properly done, is merely deducing the one constant from many accidentals; it is like calculating the one resultant of many and various forces acting in various directions; however numerous and different the several forces may be that give motion to a body, the resulting movement of that body must be one single mean result. A method for obtaining such mean results arithmetically from a multitude of regularly successive numbers has been noticed in the Third Number of the 'Proceedings'; and this method will be brought into use for the present inquiry, as it greatly facilitates the just appreciation of meteorological actions individually, as well as their correlation, for any period of the year, and at any part of it. The point immediately under consideration may perhaps be elucidated by reference to an example. The temperature of November 17, as determined by taking the arithmetical mean of the sixteen varying values ascertained by observation for this day during sixteen consecutive years, is 40°·5: but this is an accidental value (not the normal value); it does not indicate the actual influence brought to bear on meteorological phenomena by temperature, on the date specified. That this is the fact is proved by combining the value for this day with the three values preceding and the three succeeding the day—the mean of these seven being 43°·2, whilst the mean of the

seven ending with November 17 is 43°·8. Each of these latter values must indicate more correctly the permanent temperature and the *actual* thermometric influence on the date in question than 40°·5 does; this last value is arithmetically correct, probably, only for a very limited locality, and no doubt it belongs purely to the special sixteen years: 43°·9 is the efficient normal value that has been eliminated arithmetically from the whole series, for November 17.

The normal value, the actual true weight, proper to each day in the year having been eliminated from the whole mass of values for the several meteorological particulars, these normal values will be used for ascertaining the conditions of the atmosphere characterizing the equinoctial winter and summer,—the essential progression of each meteorological element from day to day being by this means clearly represented.

The questions of first interest are, Does the temperature of the atmosphere recede in the so-called blackthorn winter? and does it augment in the so-called St. Martin's summer? But convenience requires that the date of these seasons should first be determined, at least proximately. It seems clear that we must look for the blackthorn winter somewhere about the time that the blackthorn is in blossom; and it may therefore be assumed that it occurs, generally, in April, or in the last half of April and first half of May. St. Martin's summer, it seems equally clear, must have such a position as to include the 11th of November (this being St. Martin's day); and the early part of November may be assumed to be the season.

The mean temperature for the year, which is 49°·4, occurs on May 5; the mean value for April is 46°·8, that for May 52°; and the temperature for the 21st of April is 47°·5. The temperature of April is 4°·9 higher than that of March; and the temperature of May is 5°·2 higher than that of April. The last day of April has a temperature 8°·89 above that of the first day: this gives a daily rate of increase of 0°·18,—the mean rate of the increase from the coldest day to the hottest being 0°·13. The rate of increase for May is 0°·22. The smallest increase for any one day's interval is 0°·1 in April, and 0°·14 in May—each day in May, with the exception of the first, giving a higher amount than 0°·14, and the last week in April giving a mean of 0°·14. Considering that the mean daily increment, from lowest to highest, is 0°·13, it is quite clear that neither of these months is marked by a retrograde, nor even by a stationary, temperature: augmentation goes on at

2 A 2

least at an average rate, although the sun at the time has considerably passed the period of his maximum rate of change.

We must then seek for some other peculiarity that will serve to account for the sensible character of the season. What is the hygrometric state of the air? The mean temperature of the dew-point for the year, which is 43°, occurs on May 12: the mean value for April is 38°·6, that for May 44°; and the value for the 21st of April is 38°·9. The daily rate of increase for April is 0°·09, and that for May 0°·23, the mean rate from lowest to highest being 0°·12. On April 21, the dew-point temperature has risen 25 per cent. of its total annual rise; but atmospheric temperature, at the same date, has risen 39 per cent.

On the 21st of April the humidity is at its minimum value for the year, viz. 71·7. This is the essential fact, which solves the problem: the 21st of April differs from every other day in the year in this respect; and the blackthorn winter reaches its culminating point on this day: the evaporation produced by this low degree of humidity gives rise to that peculiar feeling of cold which characterizes the season. But this excessive evaporation depends as much upon the *high* temperature of the atmosphere as upon the low temperature of the dew-point. June is the month that has the lowest mean value for humidity, and this value is 73·7: but the period April 19—May 18 has the value 73·4. On April 12 the rise in the atmospheric temperature is 39 per cent. of the total rise in the year; but a thermometer subjected to the heating-power of the sun's rays, though not actually in sunshine, rose 48 per cent. of its total rise.

Atmospheric pressure on April 21 is just at the mean value for the year; and the value for the period April 19—May 18 is 0·02 in. below the mean.

The quarter from which the wind blows at this season is the north-east. The mean value for the year for the N.E. quarter being 6·85, the value for the period April 19—May 18 is 9·3; and not one of the calendar months has a value so high has this,—the highest monthly value being 9·1 for April. On April 21 the direction of the wind is N.E. or N.E. by N.

The force of wind for the period April 19—May 18 is somewhat above the average; whilst for April 21 it is somewhat below the average. The sky is far more clear of cloud than on the average; but the amount of cloud is not at a minimum: the lowest value for this particular, viz. 6·0, occurs on September 4; whilst the value for the period April 19—May 18 is 7·7, and the

average for the year is 9·1. The heat received from the sun's rays at this period of the year is great, owing to the transparency of the atmosphere and the clearness of the sky: this perhaps renders the sense of coldness the more conspicuous and distressing.

The low value for humidity is thus shown to be the dominating characteristic of the equinoctial winter. At this season of the year a great advance is observable in temperature; and the peculiarity of the season is explained by the fact that it is the period of the year in which the temperature *rises* to its highest point *with an arctic atmosphere*: the temperature continues to rise, subsequently, as the north declination of the sun increases; but this progress in the sun's position brings to our latitudes in the temperate zone a moist, as well as warm, tropical atmosphere. The tendency in the atmosphere to flow from the N.E. quarter is at its maximum intensity on April 19: on May 10 the N.E. is supplanted by the S.W. current; and this quarter maintains the preponderance until September 1. At the period of year which is under review, the source from which our atmosphere proceeds is a region of ice, in which the temperature had been much below the freezing-point for months; and the vapour of its atmosphere is reduced to its lowest amount, prior to its flowing to the lower latitudes. The temperature does not rise to 32° in the neighbourhood of the magnetic pole until June 10,—this date having been determined by a reduction of Sir John Ross's copious Tables for temperature to normal values*.

Some of the meteorological details adverted to in this discussion may not be quite trustworthy, owing to the means by which the values were originally taken. The imperfection obtains in three particulars, namely, direction of wind, force of wind, and cloudiness of sky. The direction of the wind, however, was determined under conditions that would render the observations, perhaps, more than *commonly* worthy of being relied upon. The direction was determined by the course of the lowest clouds, which were watched by the observer standing on a large circle that had each (true) point of the compass marked upon it, as connected with a perpendicular pole erected in the centre. These means made it easy, usually, to ascertain the direction the clouds took within 5° (*i. e.* less than half a point); and the direction of the clouds was commonly registered daily with great accuracy under the thirty-two points of the compass. The imperfection in the means used

* See 'Meteorology of Newport,' Appendix C.

for observation in these particulars had no obvious tendency to produce error in one direction rather than in another; and probably the values as eliminated from the mean results of sixteen years' observation do not in any appreciable degree vary from the truth.

The next question respects the progression of temperature in October and November. The mean temperature for the year recurs in the autumn on October 20, this mean value being 49°·4. The mean temperature for October is 50°·6, and that for November 44°·4; the temperature for November 9 is 45°·7. The temperature of October is 6°·68 lower than that of September; and the temperature of November is 6°·18 lower than that of October. The last day of October has a temperature of 6°·96 below that of the first day; this gives a daily rate of decrement of 0°·23, the mean rate of decrement from the hottest day to the coldest being 0°·12. The rate of decrement for November is 0°·18. The smallest decrement for any one day's interval in October is 0°·14; and it is 0°·12 down to the 27th of November; from this last date the decrement diminishes, and subsides to 0° on the 4th of December,—the downward movement setting in again on December 10. During the period November 9–13, the daily decrement is as much as 0°·24. If it be correct to take Martinmas-day as determining the position of the equinoctial summer, known as St. Martin's summer, it becomes clear that this season is marked by a rapid decline of temperature; and if it is to be placed anywhere between October 1 and November 27, it becomes clear that it is attended with a decline of temperature exceeding the average rate.

We are thus reduced to the necessity, here also, of seeking for the peculiar condition of the atmosphere in some other meteorological element instead of atmospheric temperature. The mean temperature of the dew-point recurs on October 31,—this mean being 43°. The mean value for October is 48°·5, that for November 40°·4, and the temperature for the 9th of November is 41°·4. The daily rate of decrement for October is 0°·18, and that for November 0°·15,—the mean rate from highest to lowest being 0°·1. On November 9 the dew-point temperature has fallen 62 per cent. of its total fall; but atmospheric temperature, at the same date, has fallen 69 per cent.

On the 9th of November the value for humidity stands at 82·6,—the maximum for the year being 87·6, and the mean for the year 78·6. The maximum for this particular occurs on December 3;

and this day might be regarded as the commencement of a secondary summer, inasmuch as the temperature, being 42°·07 (7°·31 below the mean for the year) on this day, does not fall below this value until December 11. But the extreme value for humidity, which distinguishes the 3rd of December from every other day in the year, is surely here the dominant characteristic, and not the temperature of the air. The 9th of November may be regarded as the day on which the equinoctial summer, or St. Martin's summer, culminates; because the humidity attains a high and a maximum value on that day. Excessive humidity and consequent defective evaporation are the cause of the sensible warmth which attracts attention.

Atmospheric pressure, on November 9, is at 30·019 in.; and this is ·049 above the mean for the year. On December 3 the pressure is ·062 lower than this, and therefore ·013 below the mean.

The S.W. wind has the ascendant during the season: the wind blows from this quarter for a long period previously, and is supplanted by the N.W. on November 24; but at this period of the year the wind blows pretty equally from all directions within the western half of the compass; and on the last day of November, the value for westerly winds attains very nearly its maximum, as compared with the other three quartercircle divisions of the compass.

The force of the wind on November 9 is 1·51, as compared with 2·28 the mean value, 2·78 the maximum, and 1·3 the minimum. The force is 1·96 on December 3, and it is below the mean from October 27 to December 9. The amount of cloud is great during the season, though not at the maximum.

The high value for humidity is assuredly the essential meteorological characteristic of the equinoctial summer; and this high value seems to be brought about, in a great measure, by the rapid decline of temperature. May the low temperature of the atmosphere, and the comparatively high temperature of the dew-point, be explained by the facts that the atmosphere proceeds from higher latitudes than it does during our summer, and from cold land-districts; but, whilst crossing the Atlantic, it takes up a large quantity of vapour*? On December 2 the wind blows with

* Our normal westerly wind appears to tend constantly more and more towards the N., from a very early date to a very late date in the year. Thus, it has been found that on January 20 the air-current tends mostly to the S.W. by S. point, on April 2 to the S.W., on August 3 to the S.W. by W., on October 3 to the W. by S., on December 1 to the W. by N.; and if we inter-

its maximum value for the N.W. quarter; and in the period November 27—December 5, the W. by N. point has a very high and preponderating value. The small amount of radiation to the sky, occasioned by the large amount of cloud, the high barometer,

polate the tendencies of secondary strength where the strongest tendency affects the N.E. quarter, the directions will be as follows:—

January 20, S.W. by S.	August 3, S.W. by W.
March 8, S.W.	October 3, W. by S.
April 2, S.W.	December 1, W. by N.
April 21, S.W. by W.	December 26, W.

There is one apparent exception to this law: nine different periods having been brought under review, one of these shows the strongest tendency to be to the N.E. by E., and the next tendency to be N.W. by W., on September 3; but in this instance, whilst the N.E. by E. has a very high value, the tendency to N.W. by W. is very equivocal; and probably W. might be introduced for September 3. In the middle of November the S.W. and N.W. quarters are nearly on a par, and the preponderance shifts repeatedly from one of these quarters to the other until January 6,—the N.W. quarter keeping above its mean value throughout the period November 7—January 4. It will perhaps be admitted to be probable that there is usually, if not always, an upper S.W. current even when the lower current is in another direction; and there is a *strong* probability that the N.W. stream, which proceeds from the cold regions of America, has a moist S.W. stream above it, whilst it rests on the Atlantic below; and thus the extreme humidity of the season may be accounted for, vapour being absorbed both from the surface above and the surface below.

The atmosphere always tends to find its own level, in two different senses; it never can be at rest whilst there is an inequality of surface, and it never can be at rest whilst not in a state of equilibrium in regard to weight. When there is a level surface, there is not necessarily equilibrium in weight; and if there were equilibrium in weight, there would not necessarily be equality of surface. The movement which tends to establish equality in one of these respects commonly has the effect of deranging equality in the other respect. When a body of air flows from low latitudes (say, from the polar sides of the tropics) to higher latitudes, the area that it has to flow over constantly diminishes, right and left (or E. and W.); and it must therefore incline to augment in measurement vertically; and this must tend to shut out any upper current moving contrariwise. But when the flow is from higher to lower latitudes, the area that it may spread itself over increases, the vertical measurement (probably) diminishes, and room is left for the tropical current to continue its course overhead northward, without running *uphill*. Owing to this, there is a much stronger probability that our northerly wind, however little of the N. it may have, is accompanied with an upper southerly current, than that the southerly wind should be accompanied with an upper northerly current; and when we have a dry, cold, specifically heavy atmosphere, which in itself has small vertical measurement, the normal depth of the atmosphere is generally made up by a superimposed stream from the S., and then we find that the heavy fluid and the light fluid together press with more force upon the mercury of the barometer than the light fluid alone does, even though the vertical measurement be the same in each case. The

the stagnant state of the air, would all contribute to the oppressive sensible warmth of the season; and the contribution afforded by these particulars is much less at the early part of December than at the early part of November. The temperature falls below 32° at the magnetic pole on September 3.

Lest the foregoing statistics should be supposed to be artificial results obtained by an objectionable system of deducing mean (or "normal") values from the actual values, the following facts taken from the unreduced values may be stated. There are 52 ten-day groups (groups of ten consecutive days) included in October and November: seven only of these groups show an increase of temperature when compared with a preceding group; each of these seven *plus* values is counterbalanced by its two proximate values; and, with one exception, they are each counter-balanced by one proximate value. The following numbers give the daily progression as belonging to these 52 ten-day groups:—

−0°·31	−0°·23	−0°·19
−0·17	−0·31	−0·32
−0·26	−0·14	−0·21
−0·49	+0·04	−0·62
−0·44	+0·08	−0·55
−0·22	−0·36	−0·10
−0·36	−0·06	−0·21
−0·43	−0·32	−0·05
−0·34	−0·10	−0·05
−0·23	+0·09	−0·13
−0·36	−0·11	−0·09
−0·45	+0·21	+0·05
−0·28	−0·19	−0·32
+0·10	−0·30	+0·12
−0·19	−0·33	−0·11
−0·22	−0·23	−0·23
−0·26	−0·37	−0·31
−0·47		

polar atmosphere possesses the same weight, in smaller measure, as the tropical atmosphere does; and when the polar atmosphere flows towards the tropics, it will necessarily, if in a state of equilibrium, leave a depression above, which the tropical atmosphere will necessarily flow into. There appear, therefore, to be two distinct reasons why a northerly wind should be accompanied with an upper southerly current; and each of these is opposed to the converse action, namely, that of a northerly upper current accompanying a southerly wind. The same two reasons serve to explain the known fact that the mercurial column usually stands higher with northerly winds than with southerly winds.

XXXII. *Meteorological Report of Hurricane at Seychelles, on 11th and 12th October,* 1862. By Mr. R. P. Brunton. Communicated by the Secretary of State for the Colonies.

	Wind.	Force.	Weather.	Barometer.
				inches.
Saturday, Oct. 11, noon ...	S.E.	4	o. c. q. r.	29·950
4 P.M......	S.	5	o. c. q. r.	29·883
8 P.M......	S.W.	7	o. c. q. r.	29·900
12 P.M......	W.S.W.	9	o. c. q. r.	29·826
Sunday, Oct. 12, 4 A.M......	W.N.W.	7	c. q. r. t.	29·782
8 A.M......	W.N.W.	11	c. q. r.	29·710
noon......	W.N.W.	11	g. c. q. r.	29·700
2 P.M......	N.W. by W.	8	g. c. q. r.	29·748
			g. c. q. r.	29·834
4 P.M......	N.W.	6	o. r. q.	29·902
8 P.M......	N.N.E.	4	....	29·932
12 P.M......	N.E.	1	o. c.	29·960

o. Signifies overcast.
c. Signifies cloudy.
q. Signifies squally.
r. Signifies heavy rain.
g. Signifies gloomy.
t. Signifies thick.

Remarks.—This hurricane, the only one on record as having done so, passed directly over Mahé; it was accompanied by incessant and very heavy rain, but with no thunder or lightning. It was probably a cyclone, of no very great diameter, as the 'Nepaul' Steam Packet experienced it at 30 miles distance from the island, and had the wind S.E. and E., on Saturday night.

The 'Nepaul' lost two of her boats.

Since Wednesday 15th the weather has been fine. Wind S.S.E. to S., with a few slight showers.

XXXIII. *Cirri Clouds and Aurora.* By H. WOLLASTON BLAKE, Esq. Communicated by J. GLAISHER, Esq., F.R.S., Secretary.

IT has occurred to me that some observations that I made in connexion with the display of the aurora borealis which took place on Sunday the 14th of December last might be interesting to you, and possibly worthy of record in the event of any similar peculiarities being noticed hereafter by others.

I was walking that evening, between ½ past 3 and 4 o'clock, to my brother's house, Danesbury, near Welwyn, Hertfordshire, where I was then staying, when I was struck with a remarkable appearance of the cirri clouds, that seemed to radiate from a confused mass of light clouds, which occupied the northern horizon; the edges of these lines of cirri were pretty clearly defined, and extended upwards, fan-shaped, towards the zenith; there was also a narrow belt of cloud stretching from the eastern horizon through the zenith to within 20° or 30° of the western horizon, forming a marked fixed line across the sky, under which were passing at moderate intervals, rather rapidly, some fleecy clouds. This appearance of the higher cirri immediately brought to my recollection something of a very similar character which I had noticed when an undergraduate at Cambridge in 1836, on the afternoon preceding the remarkable aurora that occurred in that year, and likewise reminded me of what I had on one intermediate occasion observed to a much smaller extent before an aurora. On reaching my brother's house, about 4 P.M., I immediately remarked that I should not be surprised if we had an aurora that evening, which prognostication was treated by all present with much incredulity; but I explained my reasons for thinking such a thing highly probable, and as soon as it was dark went out to observe the sky. I soon satisfied myself that there was a remarkable luminosity in the N.; and between 6 and 7 P.M. the brilliant streamers and other phenomena of that display, which I need not further describe, took place, and continued with varying effect till about 9. I cannot remove from my mind a strong impression that what I noticed in daylight as a singular arrangement of the cirri was in fact an auroral display then going on, and that there is some connexion between the cirri in the highest regions of our atmosphere and the electrical phenomena of an aurora. And when I couple this idea with the observations made by Mr. Glaisher during his late balloon ascents, on which occasion the cirri appeared to be as far removed from him at his highest elevation as when on

the earth, it seems we must look for some other cause for their formation than that of aqueous vapour, especially when the dryness and the extremely low dew-point of those regions are likewise considered. I am not aware whether anything of the nature I have described has been noticed and recorded before, but I have ventured to think it is of sufficient interest to warrant my putting these remarks on record.

XXXIV. *Climate of Belize, British Honduras.*
By the Hon. Samuel Cockburn.

There are two descriptions of N. winds generally prevalent at this time of the year (January),—one with wind from the N.E., unaccompanied with rain and dampness, very pleasant and agreeable, and called the "dry N.;" the other with wind from the N.W., attended with thick mists and a constant dripping, mizzling rain, very damp and disagreeable, is called the "wet N." The latter always produces a host of complaints—none of them very serious, however, as the malaria seldom continues long.

Sometimes, during the northers, it is quite calm and still in Belize; but the noise of the breakers dashing against the reef and islands in the gulf is distinctly heard, and indicates the state of the weather outside.

The pilots here say, when the water is clear and transparent outside, foul weather is sure to set in from the N.

Earthquakes are not frequent here—an alluvial soil distant from any volcanoes—but, when they do occur, are supposed to be the effect of convulsions in the far interior, where volcanos abound.

An earthquake occurred at 2.25 A.M. on the 14th of January, 1863. The shock was slight, and lasted about two seconds: motion horizontal. That on the 19th of December, 1862, has been ascertained to have occurred at Guatemala, and extended more sensibly towards the Pacific; but I have not been able to learn whether it did any damage.

At certain seasons of year, when the swamps are either quite full or thoroughly dry, no sickness occurs to speak of; but when they are only partially dry (in a marshy state), with the land-wind prevailing, then the deleterious emanations from decomposing vegetable matter affect the sanitary state of the place in a very

sensible degree. But it is principally the lower orders, and the dirty and filthy localities, that are seriously attacked.

I have just learnt, from an authentic source, that 150 buildings and 14 churches were destroyed at Guatemala by the earthquake of the 19th of December, 1862.

Comparative Averages for the last Five Months.

Date.	Thermometer.				
	Max.	Min.	Mean.	Range.	
August	° 84·83	° 81·49	° 83·22	° 3·340	
September	84·72	81·46	83·05	3·225	
October	82·14	77·66	79·58	4·816	
November	78·25	72·75	75·49	5·500	
December	77·60	74·23	75·98	3·280	
	407·54	387·59	397·32	20·161	
Mean daily average from Aug. to Dec. 1862.	81·51	77·52	79·46	4·032	
Date.	**Barometer.**				
	Max.	Min.	Mean.	Range.	Rain.
	inches.	inches.	inches.	inch.	inches.
August	30·02	29·93	29·97	0·092	4·67
September	29·99	29·91	29·95	0·073	7·40
October	30·02	29·94	29·98	0·085	2·63
November	30·19	30·02	30·08	0·170	5·23
December	30·11	30·04	30·06	0·075	5·07
	150·33	149·84	150·04	0·495	25·00
Mean daily average from Aug. to Dec. 1862.	30·07	29·97	30·01	0·099	5·00

I have appended a comparative statement of the mean results of the observations made since my arrival here.

Meteorological Register, Belize, British Honduras, for the Month of December 1862.

Date.	Thermometer. Max.	Thermometer. Min.	Thermometer. Mean.	Thermometer. Range.	Barometer. Max.	Barometer. Min.	Barometer. Mean.	Barometer. Range.	Barometer. Rain.	Remarks
	°	°	°	°	inches.	inches.	inches.	inch.	inch.	
1.	81·00	79·50	80·16	1·50	30·10	30·05	30·08	0·05	0·11	
2*.	81·50	79·50	*80·50	2·00	30·12	30·03	30·07	0·09	*0·03	Rainbow at 6 A.M.
3*.	80·00	78·50	79·12	1·50	*30·00	*30·00	*30·00	*0·00	0·28	
4	81·00	79·00	80·00	2·00	30·05	29·98	30·01	0·07		
5*.	*82·00	77·00	80·06	5·00	30·05	*29·92	30·00	0·13	......	Total eclipse of moon†, change of weather, rain, "wet N."
6.	78·00	76·50	77·12	1·50	30·05	30·00	30·01	0·05	0·08	
7.	75·00	71·00	73·30	4·00	30·23	30·11	30·17	0·12	0·27	
	558·50	541·00	550·26	17·50	210·60	210·09	210·34	0·51	0·77	
	79·79	77·29	78·61	2·50	30·09	30·01	30·05	0·072	0·11	
8*.	73·50	69·00	70·83	4·50	30·21	30·18	*30·20	0·03		
9.	73·75	71·00	72·58	2·75	30·18	30·15	30·16	0·03		
10*.	75·00	71·50	73·00	3·50	30·10	30·09	30·10	*0·01	0·18	
11*.	79·00	72·00	74·25	*7·00	30·07	30·00	30·04	0·07	*0·03	
12.	79·00	77·00	77·75	2·00	30·02	29·94	29·99	0·08	0·28	"Dry N."
13.	78·50	77·00	77·66	1·50	30·05	29·95	29·99	0·10	0·04	
14.	80·75	77·50	78·91	1·25	30·05	29·96	30·00	0·09	0·70	
	539·50	515·00	524·98	22·50	210·68	210·27	210·48	0·41	1·23	
	77·07	73·57	75·00	3·21	30·10	30·04	30·07	0·059	0·18	

† Observations made with equatorial forwarded to R. A. S.

15*.	*82·00	79·00	80·21	3·00	30·04	29·95	*29·98	0·09		
16.	77·50	75·00	76·25	1·50	30·10	30·02	30·07	0·08	......	Rain, "wet N."
17*.	74·00	70·00	72·15	4·00	30·20	30·03	30·13	*0·17	*1·16	Gusty, squally.
18*.	72·00	*67·50	69·58	4·50	30·22	30·14	30·18	0·08	0·10	Gloomy, stormy night.
19.	74·00	68·00	71·50	6·00	30·17	30·12	30·14	0·05	......	Earthquake 7.15 P.M., slight shock.
20.	74·00	70·00	72·50	4·00	30·18	30·10	30·15	0·08	......	Blowing hard all night.
21*.	72·00	69·00	71·00	3·00	*30·24	30·14	30·08	0·10	0·09	
	525·50	498·50	513·19	26·00	211·15	210·50	210·73	0·65	1·35	
	75·07	71·21	73·31	3·71	30·16	30·08	30·10	0·093	0·19	
22*.	76·00	70·00	72·87	6·00	30·20	30·14	30·16	0·06	*1·03	Settled and fine.
23.	76·00	71·00	72·70	5·00	30·15	30·09	30·12	0·06	0·11	
24.	77·00	73·50	75·66	3·50	30·10	30·06	30·07	0·04		
25.	77·50	75·00	76·25	2·50	30·10	30·00	30·04	0·10		
26.	79·00	73·00	76·80	6·00	30·10	30·01	30·07	0·09	0·13	
27.	79·00	76·25	77·80	2·75	30·07	30·00	30·04	0·07	......	Rosy sunset, the whole horizon round
28*.	78·50	78·00	78·17	*0·50	30·17	30·02	30·05	0·15		beautifully tinged with pink.
	543·00	516·75	530·25	26·25	210·32	210·32	210·55	0·57	1·27	
	77·57	73·82	75·75	3·75	30·05	30·05	30·08	0·081	0·18	
29.	78·50	76·00	77·25	2·50	30·20	30·00	30·03	0·10		
30*.	79·50	75·00	77·83	4·50	*30·00	*30·00	30·00	*0·00		
31.	79·00	76·25	77·88	2·75	30·13	30·06	30·08	0·07	0·45	
	237·00	227·25	232·96	9·75	90·23	90·06	90·11	0·17	0·45	
	79·00	75·75	77·65	3·25	30·08	30·02	30·04	0·056	0·15	

Meteorological Register, Belize, British Honduras, for the Month of December 1862.

Thermometer—Weekly Totals.				Barometer—Weekly Totals.				
Max.	Min.	Mean.	Range.	Max.	Min.	Mean.	Range.	
558·50	541·00	550·26	17·50	210·60	210·09	210·34	0·51	
539·50	515·00	524·98	22·50	210·68	210·27	210·48	0·41	
525·50	498·50	513·19	26·00	211·15	210·50	210·73	0·65	
543·00	516·75	530·25	26·25	210·89	210·32	210·55	0·57	
237·00	227·25	232·96	9·75	90·23	90·06	90·11	0·17	
2403·50	2298·50	2351·64	102·00	933·55	931·24	932·21	2·31	Totals of the Month.
77·53	74·14	75·86	3·29	30·11	30·04	30·07	0·078	Average of the Month.
Weekly Averages.				Weekly Averages.				
79·79	77·29	78·61	2·50	30·09	30·01	30·05	0·073	
77·07	73·57	75·00	3·21	30·10	30·04	30·07	0·059	
75·07	71·21	73·31	3·71	30·16	30·08	30·10	0·093	
77·57	73·82	75·75	3·75	30·13	30·05	30·08	0·081	
79·00	75·75	77·65	3·25	30·08	30·02	30·04	0·056	
388·50	371·64	380·52	16·42	150·56	150·20	150·34	0·362	Totals of Weekly Averages.
77·70	74·33	76·10	3·28	30·11	30·04	30·06	0·072	Average of the Weeks.
77·53	74·14	75·86	3·29	30·11	30·04	30·07	0·078	Average of the Month.
155·23	148·47	151·96	6·57	60·22	60·08	60·13	0·150	
77·60	74·23	75·98	3·28	30·11	30·04	30·06	0·075	Mean Daily Average.

Thermometer.

	°	on the	at
Hottest day	...82·	... 5th...	4 P.M.
„	......82·	...15th...	10 A.M.
„	......82·	...15th...	2 P.M.
Coldest day	...67·50	...18th...	8 A.M.
Greatest mean	80·50	... 2nd..	
Lowest mean	...69·58	...18th...	
Greatest range	7·00	...11th...	
Lowest range	... 0·50	...28th...	

Barometer.

Highest	........30·24	...21st...	10 A.M.
Lowest	.........29·92	... 5th...	4 P.M.
Greatest mean	30·20	... 8th...	
Lowest mean	...29·98	...15th...	
Greatest range	0·17	...17th...	
Lowest range	... 0·01	...10th...	

On the 3rd and 30th there was no variation.

Rainy days	17
Greatest quantity on 17th	1·16
Least quantity, 2nd & 11th	0·03
Total rain during the month	5·07
Average per day	0·16355

Meteorological Register, Belize, British Honduras, for the month of January, 1863.

Date.	Thermometer. Max.	Thermometer. Min.	Thermometer. Mean.	Thermometer. Range.	Barometer. Max.	Barometer. Min.	Barometer. Mean.	Barometer. Range.	Rain.	Wind.	Remarks.
	°	°	°	°	inches.	inches.	inches.	inch.	inch.		
1*.	80.00	77.50	78.50	2.50	30.16	30.07	30.12	0.09	......	E.*	A halo round the moon.
2*.	78.00	77.25	77.81	0.75	30.09	30.04	30.06	0.05	......	E.	
3.	78.75	77.50	78.45	1.25	30.05	30.00	30.02	0.05	......	E.	
4*.	*80.75	78.00	79.95	2.75	30.03	29.98	30.00	0.05	......	E.	
5*.	80.00	80.00	*80.00	0.00	30.03	30.00	30.01	*0.03	......	E.	Fine.
6.	80.00	79.00	79.44	1.00	30.05	29.96	30.00	0.09	......	E.	
7.	79.75	77.95	78.92	1.80	30.12	29.97	30.06	0.15	......	E.	
8*.	79.00	76.00	77.37	3.09	30.10	30.03	30.05	0.07	......	E.	Beautiful rainbow in the N.E., 8 A.M.
9*.	79.50	77.25	78.19	2.25	30.07	30.04	30.06	*0.03	......	E.	Squally.
10.	79.50	74.00	76.95	5.50	30.03	29.99	30.00	0.04	......	E.	
	795.25	774.45	785.58	20.80	300.73	300.08	300.38	0.65			
	79.52	77.44	78.56	2.08	30.07	30.01	30.04	0.06			
11.	79.00	76.00	77.04	3.00	30.11	30.03	30.07	0.08	......	E.	Fine.
12.	78.00	74.50	77.12	3.50	30.16	30.11	30.14	0.05	......	N.W.	
13*.	79.00	77.75	78.15	1.25	30.10	30.06	30.09	0.04	*0.65	E.	
14*.	79.75	78.00	78.75	1.75	30.01	29.96	29.99	0.05	0.11	N.E.	*Earthquake.
15*.	80.50	79.00	79.70	1.50	29.90	*29.81	*29.86	0.09	......	S.E.	*Brilliant sheet-lightning in the W.
16*.	70.25	68.00	69.37	2.25	30.26	30.15	30.19	0.11	*0.03	W.	at 7 A.M.; sudden change; squally.
17.	72.75	65.00	68.44	7.75	30.30	30.17	30.25	0.13	......	N.W.	Land wind.
18.	75.00	69.00	71.75	6.00	30.17	30.07	30.13	0.10	0.06	N.E.	"Wet N."
19*.	79.50	75.00	77.25	4.50	30.08	30.05	30.07	*0.03	0.56	S.*	Bright crimson sunset.
20*.	77.75	75.00	76.44	2.75	30.15	30.08	30.12	0.07	......	N.W.*	Rainbow N.E. at 4 P.M.
	771.50	737.25	754.01	34.25	301.24	300.49	300.91	0.75	1.41		
	77.15	73.72	75.40	3.42	30.12	30.05	30.09	0.07	0.14		

Meteorological Register, Belize, British Honduras, for the month of January, 1863 (*continued*).

Date.	Thermometer.				Barometer.						Remarks.
	Max.	Min.	Mean.	Range.	Max.	Min.	Mean.	Range.	Rain.	Wind.	
	°	°	°	°	inches.	inches.	inches.	inch.	inch.		
21.	74.00	70.00	71.93	4.00	30.22	30.14	30.17	0.08	0.07	N.W.	"Dry N."
22.	74.75	68.50	71.85	6.25	30.18	30.12	30.15	0.06	......	N.	Rosy sunset.
23.	76.00	72.50	74.25	3.50	30.14	30.10	30.11	0.04	......	N.E.	
24.	76.00	73.50	74.83	2.50	30.17	30.10	30.14	0.07	......	N.E.	
25.	76.00	71.00	73.82	5.00	30.22	30.10	30.15	0.12	......	N.W.	
26.	75.25	73.75	74.37	1.50	30.16	30.08	30.12	0.08	0.04	N.W.	"Wet N."
27.	77.00	73.50	75.37	3.50	30.14	30.06	30.09	0.08	0.09	N.W.	Damp and gloomy.
28*.	72.00	67.50	68.81	4.50	*30.35	30.20	30.27	0.15	0.08	N.W.	
29*.	68.00	*62.00	*64.65	6.00	*30.35	*30.23	*30.29	0.12	......	N.E.*	Coldest day.
30*.	71.00	*62.00	67.50	*9.00	30.29	30.20	30.24	0.09	......	W.	Fine and bracing.
31*.	73.50	69.50	71.05	4.00	30.18	30.00	30.10	*0.18	......	E.	"Dry N."
	813.50	763.75	788.43	49.75	332.40	331.33	331.83	1.07	0.28		
	73.95	69.43	71.67	4.52	30.22	30.12	30.17	0.098	0.03		
	795.25	774.45	785.58	20.80	300.73	300.08	300.38	0.65			
	771.50	737.25	754.01	34.25	301.24	300.49	300.91	0.75	1.41		
	813.50	763.75	788.43	49.75	332.40	331.33	331.83	1.07	0.28		
	2380.25	2275.45	2328.02	104.80	934.37	931.90	933.12	2.47	1.69	Total of the Month.	
	76.78	73.40	75.10	3.38	30.14	30.06	30.10	0.08	0.05	Average of the Month.	

	79·52 77·15 73·95	77·44 73·72 69·43	78·56 75·40 71·68	2·08 3·42 4·52	30·07 30·12 30·22	30·01 30·05 30·12	30·04 30·09 30·17	0·06 0·07 0·10	0·14 0·03	
	230·62	220·59	225·64	10·02	90·41	90·18	90·30	0·23	0·17	Total of Decennials.
	76·87 76·78	73·53 73·40	75·21 75·10	3·34 3·38	30·13 30·14	30·06 30·06	30·10 30·10	0·07 0·08	0·05 0·05	Average of Decennials. Average for the Month.
	153·65	146·93	150·31	6·72	60·27	60·12	60·20	0·15	0·10	
	76·82	73·46	75·15	3·36	30·14	30·06	30·10	0·07	0·05	Mean Daily average.

THERMOMETER.

Hottest time .... 80·75 on the 4th at 2 P.M.
Coldest time .... 62·00 „ 29th at 7 A.M. and the 30th at [6 A.M.
Greatest mean......... 80·00 „ 5th.
Lowest mean .... 64·65 „ 29th.
Greatest range ...... 9·00 „ 30th.
Lowest range .... 0·75 „ 2nd.

BAROMETER.

Highest .... 35·00 on the 28th at 10 P.M. and the 29th at [10 A.M.
Lowest.................. 29.81 „ 15th at 5 P.M.
Greatest mean......... 30·29 „ 29th.
Lowest mean .... 29·86 „ 15th.
Greatest range ...... 0·18 „ 31st.
Lowest range .... 0·03 „ 5th, 9th, and 19th.

On the 5th there was no variation in the thermometer. On the 29th and 30th it was very cold: the glass at 4 o'clock in the morning sunk as low as 55° in the open air. On the north of the river it was 52° in the open air. At the barracks it was 50° at 9 A.M. in the shade.

Rainy days, 9. inch.
Greatest quantity fell on the 13th .... 0·65
Least „ „ 16th .... 0·03
Total during the month .... 1·69
Average per day .... 0·0545

XXXV. *Description of Baudin's Minimum-Thermometer.* By H. A. Negretti, Esq.

This instrument resembles the ordinary Rutherford's thermometer in appearance; its indications are given by the expansion and contraction of alcohol; and the minimum temperature is likewise registered by a glass index being pulled back and left behind by the alcohol, as in the case of the Rutherford's instrument. There is, however, a great improvement in Baudin's instrument; for, whilst the Rutherford's thermometer can only be used in a horizontal position, Baudin's can be used either horizontally or vertically, as necessity may require: this important change is effected in the following manner:—

Instead of the index in the thermometer being loose and free, to run up and down according to the position in which the instrument is held, as in Rutherford's, the index in the new instrument is made to fit the base of the tube as nearly tight as possible, so much so that, in holding the thermometer even upside down or shaking it, the index will not shift from its position; but, inasmuch as a minimum-thermometer with an immovable index could not be set when required for observation, and would consequently be useless, the inventor has introduced behind the index a piece of solid glass, about 1½ in. in length, which moves freely in the alcohol. The addition of the weight of this piece of glass on the top of the index, when turned *upside down*, forces the index down to the edge of the alcohol; and it is there left, as in the case of the ordinary Rutherford's thermometer. It is, therefore, by turning the thermometer upside down, and letting the movable piece of glass fall on the index, that the index is driven to the end of the alcohol; after this operation, the thermometer is hung up, either horizontally or vertically, and will then be ready for use.

BOOKS AND NOTICES.

XVI. *Magnetic Storms and Earth-Currents.*

CHARLES V. WALKER—Philosophical Transactions of the Royal Society, vol. clii. pp. 203–219. 1862, February 13.

J. LAMONT—Archives des Sciences Phys. et Nat., Nouvelle période, tom. xiii. 1862, April 20.

MAJOR-GENERAL ED. SABINE, R.A., President R.S.—The Reade Lecture on the Cosmical Features of Terrestrial Magnetism, pp. 24. 1862, May.

THE substance of Mr. Walker's paper, and the conclusions to which he had arrived, were given in these 'Proceedings,' No. 3, p. 160. His paper has since been printed *in extenso* in the 'Philosophical Transactions.'

In illustration of his 7th conclusion (Proceed. Brit. Met. Soc., p. 161), that the direction of a current in one part of a plane on the earth's surface coincides with its direction in another part of the plane, he says:—

"We speak of electric *currents* in this inquiry; the word conveys the idea of length without width. The currents in question necessarily and evidently cover large areas, presenting as it were an *electric plane*. Passing on from the determination of mere direction, I was able to survey the two sides of the same plane. By reference to the map, the RamsgateHarbour-London and the Dover-Tonbridge lines are not many degrees from being parallel. They are about 20 miles apart; the former is 67 miles, and the latter 45 miles in length. I have at Ashford junction a turn-plate or switch. When desiring to make the observations on the Ramsgate-London line, I call Ashford and give the word 'branch;' the reply is 'yes' or 'no,' according as it is at liberty or not, If at liberty, the switch is turned, and I have the command of the wire from Ramsgate to London, the telegraph length of which is 97½ miles; and then ...., the command is obtained of the Ramsgate-Tonbridge line.

"Observations of this kind have been made from time to time; the results are given in Table XVI.

"Column 2 gives the Ramsgate-London results, or the survey of the north side of the parallelogram; and column 1 the Dover-Tonbridge results, or survey of the south side of the parallelogram. In every instance, with a solitary exception during the two months of observation, the directions coincide; the current or drift or electric plane is at least 20 miles wide, and the behaviour of its two limits is consistent. The proportion between the values of the currents on the two sides of the plane is not constant, ... The Ramsgate-London, or 67-mile line collected by 97½ miles of telegraph wire, gives in the majority of cases a less value than the Dover-Tonbridge, or 45-mile line, collected in 46¾ miles of wire.

"TABLE XVI. Directions and Values of Earth-Currents collected at Tonbridge, 1861, November and December; from the Tonbridge-Dover, London-Ramsgate, and Tonbridge-Ramsgate lines.

Date.	Time.	Column 1.	Column 2.	Column 3.
		Dover-Tonbridge .... *u*. Tonbridge-Dover .... *d*.	Ramsgate-London .... *u*. London-Ramsgate .... *d*.	Ramsgate-Tonbridge, *u*. Tonbridge-Ramsgate, *d*.
1861.	h m	°	°	°
November 17.........	12.35 P.M.	28 *u*	10 *u*	14 *u*
November 20.........	7.34 A.M.	25 *d*	15 *d*	20 *d*
November 21.........	7.7 A.M.	0	0	0
November 22.........	7.1 A.M.	15 *u*	12 *u*	0
November 25.........	3.25 P.M.	14 *u*	0	7 *u*
November 26.........	6.35 A.M.	35 *u*	20 *u*	15 *u*
	3.24 P.M.	10 *u*	15 *u*	15 *u*
November 27.........	6.19 A.M.	10 *u*	10 *u*	15 *u*
	11.47 A.M.	15 *d*	11 *d*	10 *d*
	12.32 P.M.	16 *d*	0	0
	2.18 P.M.	28 *d*	8 *d*	20 *d*
	2.38 P.M.	26 *d*	24 *d*	29 *d*
November 28.........	6.20 A.M.	0	0	2 *u*
November 29.........	6.33 A.M.	5 *d*	2 *d*	0
	1.13 P.M.	17 *d*	23 *d*	35 *d*
November 30.........	6.22 A.M.	10 *d*	0	5 *d*
December 2.........	2.27 P.M.	22 *u*	7 *d*	5 *d*
December 3.........	6.13 A.M.	18 *d*	9 *d*	9 *d*
December 4.........	6.20 A.M.	0	5 *d*	0
	1.25 P.M.	40 *u*	27 *u*	32 *u*
December 6.........	6.39 A.M.	5 *u*	0	0
December 7.........	6.24 A.M.	25 *u*	35 *u*	42 *u*
December 9.........	7.18 A.M.	20 *u*	0	0
December 13.........	6.49 A.M.	10 *u*	20 *u*	20 *u*
December 14.........	6.35 A.M.	15 *d*	10 *d*	20 *d*
December 17.........	6.30 A.M.	10 *d*	5 *d*	5 *d*
December 19.........	6.23 A.M.	0	15 *u*	20 *u*
	8.18 P.M.	55 *d*	55 *d*	55 *d*
December 20.........	6.30 A.M.	5 *u*(?)	15 *d*	10 *d*
December 21.........	6.24 A.M.	10 *u*	20 *u*	30 *u*
December 26.........	6.34 A.M.	25 *u*	20 *u*	25 *u*
December 27.........	6.35 A.M.	15 *u*	15 *u*	20 *u*
December 28.........	6.23 A.M.	0	2 *u*	2 *u*
December 31.........	6.26 A.M.	30 *d*	25 *d*	30 *d*

"Column 3 of Table XVI., already noticed, is the Ramsgate-Tonbridge line. It makes a diagonal across the plane. The directions in all cases coincide with those of the other two lines, and so give a further evidence of consistency."

In the above Table, the degrees show the deflections of the same galvanometer needle; the three readings in each set were taken in most cases within the same minute. The letters *u* or *d* indicate a current moving *up* or *down* the line. The directions for each *u* or *d* are given at the head of the columns.

In illustration of his 9th position (*ibid.* p. 161), that the value of the current of a given length, moving in a given line of direction, is not necessarily the same as that of a current of the same line of direction produced, the following observations are made:—

"Tonbridge is almost in a direct line between London and Hastings, and very nearly equidistant....... I have a switch or turn-plate in the Telegraph Office at the Tonbridge junction, by means of which the Tonbridge-Hastings wire can be placed at my request in connexion with the Tonbridge-London wire. The direct line between London and Hastings is 53 miles. I have thus an opportunity of making observations on the whole of this line, or on either half, the direction of all three being the same. The results of these observations are given in Table XVII. Column 1 contains the value of currents collected on the whole line of 53 miles; column 2, those on the London half of 27 miles; and column 3, those on the Hastings half of 26 miles.

"TABLE XVII.—Directions and Values of Earth-currents collected at Tonbridge, 1861, November and December; from the London-Hastings, London-Tonbridge, and Tonbridge-Hastings lines.

Date.	Time.	Column 1.	Column 2.	Column 3.
		Hastings-London ..... *u*. London-Hastings ..... *d*.	Tonbridge-London .... *u*. London-Tonbridge .... *d*.	Hastings-Tonbridge... *u*. Tonbridge-Hastings... *d*.
1861.	h m			
November 15.........	12.34 P.M.	8° *d*	18° *d*	1° *d*
	1.56 P.M.	8 *d*	24 *d*	
November 16.........	10.19 A.M.	4 *u*	44 *u*	6 *u*
	10.53 A.M.	20 *d*	50 *d*	0
November 17.........	12.35 P.M.	5 *u*	10 *u*	4 *u*
November 20.........	7.37 A.M.	5 *d*	10 *d*	0
	10.50 A.M.	7 *u*	8 *u*	4 *u*

"TABLE XVII. (*continued*).

Date.	Time.	Column 1.	Column 2.	Column 3.
		Hastings-London ..... *u.* London-Hastings ..... *d.*	Tonbridge-London ..... *u.* London-Tonbridge ... *d.*	Hastings-Tonbridge .. *u.* Tonbridge-Hastings .. *d.*
1861.	h m	°	°	°
November 21	7.10 A.M.	0	5 *d*	0
	9.35 A.M.	12 *u*	18 *u*	0
	11.46 A.M.	4 *u*	6 *u*	3 *u*
	12.49 P.M.	0	0	5 *u*
November 23	6.22 A.M.	5 *d*	10 *d*	0
	9.1 A.M.	0	10 *u*	0
November 25	1.34 P.M.	6 *u*	12 *u*	4 *u*
	2.47 P.M.	8 *u*	5 *u*	9 *u*
	3.24 P.M.	8 *u*	23 *u*	7 *u*
November 26	6.34 A.M.	0	10 *d*	0
November 27	6.17 A.M.	0	0	0
	12.32 P.M.	7 *d*	5 *d*	5 *d*
	2.18 P.M.	0	3 *u*	0
November 28	6.17 A.M.	0	5 *u*	2 *d*(?)
November 29	6.24 A.M.	2 *u*	5 *u*	0
November 30	6.17 A.M.	5 *u*	10 *u*	0
December 2	11.48 A.M.	0	8 *d*	0
December 3	6.13 A.M.	5 *d*	0	5 *d*
December 4	6.17 A.M.	10 *d*	15 *d*	5 *d*
	1.29 P.M.	0	16 *d*	1 *d*
December 5	6.24 A.M.	5 *d*	0	5 *d*
December 6	6.37 A.M.	0		0
December 7	6.22 A.M.	0	5 *d*	0
December 9	7.16 A.M.	5 *d*	0	5 *d*
December 13	6.43 A.M.	0	0	0
December 14	6.33 A.M.	5 *u*	10 *u*	0
December 17	6.29 A.M.	0	5 *d*	0
December 18	6.20 A.M.	5 *d*	10 *d*	5 *d*
December 19	6.21 A.M.	5 *d*	10 *d*	5 *d*
December 20	6.20 A.M.	10 *d*	25 *d*	5 *d*
December 21	6.22 A.M.	15 *d*	28 *d*	10 *d*
December 26	6.30 A.M.	0	10 *d*	0
December 27	6.34 A.M.	0	0	0
December 28	6.21 A.M.	0	0	0
December 31	6.23 A.M.	0	0	0

"If the value of these derived currents depended simply on the mere distance between the earth-plates or observing-stations, and their bearing each on the other, it is obvious that the values in columns 2 and 3 would be identical, or in this case nearly so. The London-Tonbridge wire-length is 41 miles; the Tonbridge-Hastings 33; so that the value on the latter length should be a little higher if anything, the resistance being less. But, with very rare exceptions, the Tonbridge-Hastings values are seen to be greatly below the Tonbridge-London. The contrast is remarkable. In some cases the differences are very conspicuous. I have made a sufficient number of observations, extended over two months, to satisfy myself that the one section is under all circumstances less active in derived currents than the other. This difference can only be attributed, as already suggested in my former communication, to the different geological conditions of the two sections of country, a difference which may operate in two ways: either the resistance of the section may be relatively great, so that the earth-plates penetrate into a portion of the electric plane that is traversed by a current of low value, and hence the derived current is comparatively low; or the resistance of the section may be relatively small, so that, although the earth-plate may penetrate into a portion of the electric plane that is traversed by a current of higher value, yet the wire resistance, in contrast with the high conducting power of the earth section, may cause the derived current to have a relatively low value."....

"Column 1 of Table XVII. contains the values given by the whole length, from London to Hastings. They differ but little, save in one or two instances, from the Tonbridge-Hastings values; and are consequently very low in comparison with the Tonbridge-London values. These facts all indicate the very notable influence of local conditions, other than the meteorological variation already noted, over the relative value of the current in different parts of the plane."

Some remarks made by Dr. Lamont in Poggendorff's 'Annalen,' 1862, No. 1, on the relation between earthquakes and magnetic disturbances, are reproduced. The relation not being sufficiently established, every fact is valuable. He says, "On December 26, 1861, at 8 A.M., while I was observing the position of the magnetic instruments (their number in the magnetic observatory being six—namely, two for declination, two for intensity, and two for inclination), I remarked that all these instruments were in an unusual state of agitation, which consisted of a rapid and irregular oscillation, and of a vertical trembling. The trembling of the needle did not last long; but although the oscillations were reduced, they lasted till half-past 8. Some days afterwards I learned that an earthquake had devastated several places in Greece, exactly at the hour of the observation referred to.

"This proves not only that the shock that is produced by the earthquake can be propagated to great distances, but that the forces which are the cause of it modify to a certain point the

magnetism of the earth. This modification doubtless consists in the production of an earth-current, since in this particular case the magnetic instruments of the Observatory were greatly agitated. I should remark that the earthquake in Greece of April 18, 1842, produced the same effect at Munich, whilst earthquakes in localities that are nearer have not hitherto exercised any sensible action."

The Reade Lecture, "On the Cosmical Features of Terrestrial Magnetism," was delivered in the Senate House of the University of Cambridge, by General Sabine, the President of the Royal Society, in May 1862. The two classes of terrestrial magnetic phenomena are "those which originate in and indicate the magnetic state of our own planet, and those which admit of a traceable connexion with bodies exterior to the earth, or forces emanating from them;" and the lecturer refers chiefly to the second of these two classes of phenomena. Referring to the magnetic observations at Berlin and Göttingen, they may be considered as having prepared the way for the present extended and complete organization, which has raised terrestrial magnetism to the dignity of an inductive science.

It was early noticed that the irregular disturbances of the magnetic needle were not confined to one place, but occurred simultaneously, and nearly to the same amount, over the whole extent of country in which the 'term observations,' as they were called, were made. At first they were supposed to be due to disturbance in the atmosphere; but this supposition fell to the ground in the presence of the extent of area over which the effects occurred.

The following extracts from the Report of the Royal Society strike the key-note of all the discoveries that have since been made, though at the same time they are too little understood and too little regarded:—

"All the magnetic elements are at each point now ascertained to be in a constant state of fluctuation, and affected by transient and irregular changes; and the investigation of the laws, extent, and mutual relations of those changes is now become essential to the successful prosecution of magnetic discovery, for the following reasons:—

"1st. That the progressive and periodical changes are so mixed up with the transitory changes that it is impossible to separate them, so as to obtain a correct knowledge and analysis of the progressive and periodical, without taking express account of and eliminating the transient and irregular; ...... and further, because the theory of these transitory changes is in itself one of the most interesting and important points to which the attention of magnetic observers can be turned, as they are no doubt intimately connected with the general causes of terrestrial magnetism, and will probably lead us to a more perfect knowledge of those causes than we now possess."

When the colonial observations were established, "it was found

that the disturbances were contemporaneous not only over a limited area in Europe, as previously known, but also at all these widely distributed stations, situated in parts of the globe most distant from each other." It was also found that, whilst the great disturbances were synchronous, yet "at stations remote from each other, the disturbance of the same element might differ widely in amount, and might occasionally be even reversed in direction;" and one magnetic element might be affected at one station, and another at another—confirming the surmise of Gauss, that various distinct forces might be in action from different sources, and their effects be intermixed in different proportions, according to the direction and distance of the place of observation from the several sources.

The first step in the study of the laws in operation was to separate a sufficient number of disturbed observations from the general mass of those recorded; and the difficulty then was to decide on some criterion by which a disturbed might be distinguished from an ordinary observation. The *magnitude* of discordance from the known mean position of the magnet at a given time was taken as "a criterion of disturbance for a first essay," care being taken that this magnitude should exceed the probable limit of irregularities for particular days; and the amount adopted was made the constant for a disturbed observation at the particular station. The experiment was successful, and "casual and irregular as the disturbances appeared in respect to the particular times of their occurrence, when viewed singly, they were in their *mean effects* strictly periodical phenomena," and exhibited "a dependence on the sun as their primary source."

The following extracts, taken *seriatim* from General Sabine's paper, will give a general idea of the chief points of interest and the author's views thereon:—

"In this view a full discussion of the particulars here adverted to was prepared for insertion in the introduction to the second volume of the 'Hobarton Observations,' then passing through the press, when, in the course of editing the English translation of the third volume of M. de Humboldt's 'Cosmos' from the proof-sheets, which were sent to me for that purpose by the author, my attention was arrested by the table in p. 402 of that volume, containing the results of M. Schwabe's continuous and systematic observation of the solar spots from 1826 to 1850, accompanied by his own general conclusion, to the following effect:—'The numbers in the table leave no doubt that at least from 1826 to 1850 the solar spots have shown a period of about ten years, with maxima in 1828, 1837, and 1848, and minima in 1833 and 1843.' Any hesitation that might have been felt in announcing the conjectured existence of such a periodical magnetic variation, unsupported by the coincidence of any other known cosmical or terrestrial variation of similar period, was at once removed. The variation observed in different years in the solar spots coincided perfectly with that which had just been recognized in magnetic phenomena, which were otherwise connected with the sun by conformity

to solar hours; and by this new and previously unsuspected relation, a very high degree of probability was given to the existence of a true and direct magnetic connexion between the earth and the central body of the solar system." . . . .

"In a discovery so unexpected and so recent as that of the cosmical connexion of the magnetic disturbances, it cannot be supposed that much can yet have become known to indicate the *mode* in which the sun's influence is exercised in the production of the phenomena of magnetic disturbance which we witness and record. The path in which we may most securely advance towards the attainment of this knowledge is by the careful and continuous study of the *effects* themselves, and by applying to them such processes of analysis as may appear most suitable to aid us in their comprehension." . . . .

"There are therefore distinguishing characters in the effects of the sun's influence in producing the disturbances in different parts of globe, which have a systematic aspect, and are not unlikely to lead to important generalizations." . . . .

"There is yet one other and most notable distinction with reference to geographical relations: the aggregate amount of disturbance varies greatly and instructively in different parts of the globe; it is small in the intertropical regions, and augments in the middle latitudes, but by no means in a ratio dependent on the increase of latitude; for as the higher latitudes are approached, the disproportion of disturbance in different *meridians* becomes excessive, and leads to the inference that in both hemispheres there are localities indicated by the peculiar magnitude of the disturbing influence as being those where that influence may possibly enter on the terrestrial surface, and from whence it may be propagated with progressively decreasing intensity." . . . .

"When these monthly tables are compared, the results are found to arrange themselves into two distinct categories, the one comprising the six months in which the sun is in the northern signs of the zodiac, and the other the six months in which he is in the southern signs. The difference of the diurnal variations shown by the two categories is of a very marked character, and is always the same in whatever part of the globe the station of observation is situated. It is obviously a periodical affection common to the whole globe, having a year as its cycle, with semiannual epochs coinciding as nearly as may be with the equinoxes." . . . .

"Such determinations made on stated days in each month have been continued for several years at some stations, without any change either of instruments or of observers; and it has been found that in the high or middle latitudes of both hemispheres there occurs a small increase both in the dip and in the force in the months when the sun is nearest to the earth, as compared with the months when his distance from our planet is greatest, *i. e.* that both the dip and the total force are greater in both hemispheres in December than they are in June. This effect cannot of course be ascribed to any influence of the seasons of summer and winter affecting either the earth or the needle by their different tempe-

ratures; for the magnetic difference is the *same* in both hemispheres, while the *seasons* are *opposite*, the higher force and dip of December being associated with winter in our hemisphere and with summer in the southern hemisphere. The amount of the difference, though small in itself, is large when tested by the amount of probable error."....

"When a mean of the undisturbed observations at each hour is taken for the entire year, the semiannual inequality of which we have recently spoken merges into an annual *mean solar diurnal variation*, evidencing its cosmical character and its connexion with the sun, first, by its period being a solar day; and secondly, by its amount in different years being subject to a variation which corresponds in period and epochs with the decennial variation of the solar spots."....

"There is a second very notable geographical distinction between the phenomena of the solar diurnal and of the disturbance variations, and it is one which bears strongly on the probability of a difference in the mode of the sun's action in producing the two classes of effects. It consists in the very different relative magnitudes of the range of the two variations in different parts of the same hemisphere. In the case of the disturbance variation, we have already noticed that its amount is much less in the middle latitudes of Europe and Asia than in Canada, while in certain parts of the north-western portions of the American continent it attains a development which renders the disproportion excessive. We have nothing analogous to this in the solar diurnal variation, which exhibits in different meridians a remarkable approach to constancy in its *amount* (varied only by distance from the dividing-line between the two magnetic hemispheres and by differences in the antagonistic horizontal force of the earth), as well as in its form and turning-hours—a constancy which contrasts strongly and systematically with the phenomena of the disturbance variation, and is apparently quite uninfluenced by any peculiarities of land and sea, near or remote."....

"We have next to notice a magnetic variation which has for its period a *lunar* day, thereby establishing the fact of the existence of a sensible magnetic influence exercised by the *moon* at the surface of the earth."....

"The peculiar feature of the lunar diurnal variation, which is constantly manifested in all the elements and at all the stations, is that of a double and symmetrical progression in each lunar day. This has been regarded by some physicists as indicating that the magnetism of the moon, of which it is the effect, is an induced magnetism. There are, however, difficulties in this supposition which appear to stand in the way of its immediate and general reception."....

"But there still remains a distinct class of magnetic variations which there is also much reason to believe are, on a more extended scale, periodical, and probably governed by cosmical relations, to the discovery of which, however, we as yet possess no clue."....

"These variations, therefore, still retain the name at first

assigned to them, of *secular* changes. That they are eminently systematic,—that in all parts of the globe they manifest themselves as due to a common cause, and that this cause is not traceable to any terrestrial changes with which we are acquainted or can reasonably conceive,—are considerations which confer a very high interest on the investigations connected with this branch of magnetical science."....

"When carefully studied, the changes in all parts of the globe are seen to concur in indicating a gradual and progressive translation of his [Halley's] two moving poles in the directions assigned by him. The gradual and extremely regular character of this movement has recently been strikingly illustrated by the results of observations conducted with suitable care and under particularly favourable circumstances, which enable us to trace the progress of the secular change, not merely from year to year, but actually from week to week, each week showing an equal aliquot part of the yearly change."....

"Whether the magnetical poles move with one motion or with several,—whether equally or unequally,—whether circular or libratory,—if circular, about what centre,—if libratory, after what manner,—are secrets as yet unknown to mankind, and are reserved for the industry of future ages."

SUNDRY NOTES.

8. *Mr. Glaisher's Balloon Trips.*—'Chevy Chase'—that grand old ballad, of which Philip Sidney said that it stirred his heart "like the sound of a trumpet"—has in it no finer episode than that of the gallant gentleman who, when his legs were smitten off, knelt down and fought upon his knee. Obviously the good knight did not know when he was beaten—a magnificent ignorance which is happily still characteristic of our race. The same high and chivalric spirit has again and again illustrated the annals of England, and not alone the records of her warlike exploits, but those of her scientific enterprises. Plain Martin Frobisher, the rough north-country skipper, when the ice-floes were crowding and crashing around his ship, could exclaim, "The ice is strong, but God is stronger;" Humphrey Gilbert, the gently born and nurtured knight of Compton Castle, when the waves were leaping and roaring in the wake of the little 'Squirrel,' knew that "Heaven was as near at sea as on land;" Walter Raleigh, greater than either, could quietly mount the scaffold, and say, as he passed his hand along the keen edge of the headsman's axe, "'Tis a sharp remedy, but one that will cure all diseases." Men who never drew a sword have felt and acted up to the same heroic pitch. There is a brute indifference to danger which is foolish and almost criminal; but there is also a readiness to face peril and to undergo privation which is the very salt of our life—the very inspiration

of our manhood. When Dr. Richardson, desperately struggling to swim across the almost frozen waters of the Coppermine River, in order to establish a communication with the opposite shore, suddenly felt his legs and arms benumbed and paralysed by the bitter cold, and yet still pushed onwards, unable to swim, but floating on his back, he was the type and the representative of our best men of science. Dr. Tyndall, outstripping the most practised mountaineers amid the crevasses and glaciers of the Alps—Mr. Glaisher calmly reading the thermometer six miles above the earth, until his eyes grew giddy and dazed, and he sank back, fainting, in the car of the balloon—such men as these, with no shouts to cheer them on, no martial music to stimulate their ardour, have shown a courage which is even finer than that of the battle-field. By mere virtue of their readiness to endure, they are enabled to achieve; prepared, for the sake of science, to become martyrs, they become victors; and they triumph supremely because they will never admit that they are beaten. In their cool, steady, and deliberate bravery, which is no mere heat of the blood, no passionate quickening of the pulse, but the fruit of a quiet resolve to do their duty, they are fit and worthy countrymen of that "astonishing infantry" which in so many a conflict has been firm and massive as a rock, hurling back in a shattered cloud of flying and gory foam the waves of valour that were dashed against it.

Undismayed by all the dangers of that wonderful journey, in which he was so near to death amidst the solemn loneliness of the sky, Mr. Glaisher has again ascended far above the clouds. Many a man might, without impeachment of his courage or his honour, have held back from a renewal of such an enterprise; but it is not of hesitating stuff that Englishmen are made. The sons of those who have construed distance and time into little more than words—who have spread themselves over the wide surface of the earth, peopling and subduing it—who have pressed the elemental forces of nature into habitual daily service—have still much work before them; and it seems as though every height which they scale, as discoverers or as conquerors, does but serve to show, gleaming in the distance, fresh fields for effort and for labour. Whilst one man, bending over crucible and retort, with a keener gaze and with a nobler motive than any of the old alchemists, gleans from his toil some indications and promises of a day when the veil that yet hides the secrets of nature shall be reverently lifted, not rudely torn away—another, his eyes raised towards the stars, already dares to hope for a time when the mysterious laws which direct the coming and the going even of the invisible wind will be plain and clear. It is upon no idle, hair-brained expeditions that Mr. Glaisher embarks; but the work he is engaged in is one the importance and the perils of which have alike been calmly calculated by men who, thoroughly competent to judge, declare the former to predominate. Those who scoff at Admiral FitzRoy because, reasoning out as best he can the data of a science still in its infancy, he sometimes makes a blunder, will be ready enough to sneer at Mr. Glaisher; meanwhile the aëronaut will aid the ad-

miral in observations which some of the hostile critics of both are almost amusingly unable to comprehend. Already has Mr. Glaisher by his various ascents demonstrated that the old hypothesis of a uniform decrease of 1° of Fahrenheit's scale for every increase in elevation of 300 feet is totally untenable, and the temperature and density of the atmosphere at great heights, as well as the strength and direction of various aërial currents, have been for the first time satisfactorily observed and recorded. The enterprise of last Tuesday was not so perilous as that undertaken in the previous autumn, but it was one for which no ordinary courage and coolness were required. Mr. Glaisher's admirable account of it has already been placed before our readers, who must have perused it with keen interest and lively sympathy. It was a swift journey into the air; the balloon, first taking an easterly course, attained in twenty-eight minutes an elevation of three miles, and then, still ascending, drifted about before the currents of wind that were encountered. Whilst Mr. Glaisher, note-book and pencil in hand, busily registered the temperature and watched the minutest variations of his instruments, Mr. Coxwell was actively engaged in the management of the balloon; and when they could spare a moment to glance at the widening view, a magnificent panorama burst upon them. They were between three and four miles above the earth. The mighty roar of London, which at a lower elevation was as grand as that of the sea itself, was now hushed, and there was no other sound that broke the great stillness and silence of the sky. Away towards the west, as the spring sun hung lower and lower yet in the horizon, the Thames glittered and glowed with a golden splendour; but far in the east there was the gleam of the white cliffs and of the sea. From Brighton to Yarmouth the coast-line could be seen, trending away until it vanished in the thick clouds that had gathered in the north. Upwards still—towards a region where the air is so rare and thin that the tiniest canary that ever fluttered in a cage would drop down through it, sheer and sharp, like a stone into a well—upwards still went the two brave men. The temperature, decreasing as they rose, was at zero when they were four miles and a half high; and their faces grew blue and purple with the extreme cold. At length, in the early twilight of March, a deepening blackness crept over the land; but still the cirri were like feathery flakes of infinitely varied colour; still, over the clouds, the sunlight streamed out in exuberant glory; still, above them, the vault of the sky was purely and perfectly blue. No spectacle more magnificent could even be conceived than that which met their eyes from the moment when they left the Crystal Palace to the time when they again reached the earth in safety amidst the marshy lands of Essex.

When the story of their first extreme perils was still fresh in public memory, we maintained that the labours of Messrs. Glaisher and Coxwell were not yet over, and that the *dernier mot* of aërostatics had not been said. Other ascents have still to be made; and their results will be anxiously watched by all thinking men.

Meanwhile, across the Atlantic, the value of the balloon in warfare has received fresh demonstrations; and Professor Lowe, his balloon fastened securely to the ground by warps, and himself provided with a thin insulated wire, has quietly surveyed the armies of the enemy through his glass, and telegraphed their motions to his own camp. In former years, a protest has been necessary against ascents made by men who had no excuse for their rashness, and who, in fact, scarcely belonged to the class of aëronauts, but rather to that of acrobats. Against similar attempts we should still direct the censure which they call for; but we are equally bound to express our sympathy and admiration for such enterprises as that which now engages our attention. Himself an educated and most intelligent man, it may be said of Mr. Coxwell that danger is minimized when it is shared in his company; and Mr. Glaisher, to whose scientific reputation no testimony of ours is needed, has now given fresh proofs of that calm, cool courage which could alone enable him to carry to a successful issue the honourable, if arduous, researches upon which he is engaged.—*From the Daily Telegraph*, 1863, April 4.

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9. *Mr. Glaisher's Tenth Balloon Ascent.*—My short letter in your impression of Saturday last informed the public of my intention to make a balloon ascent on that day. Mr. Coxwell had partially filled the balloon the previous afternoon, and resumed the operation on Saturday morning, in co-operation with Mr. Ohren, with a view to starting before noon.

The atmosphere was thick and misty, the wind on the earth was north-east, but the clouds were moving from the north with an estimated velocity of forty miles an hour, and circumstances were not favourable for reaching a height of five miles. In all my experience I find it takes an hour to reach a height of five miles, and I like an hour to descend, and therefore I want a base of at least eighty miles with air moving at the rate of forty miles an hour.

About midday a pilot balloon was sent up, which showed the wind to be due north. Mr. Coxwell proposed an hour's delay, as the breeze appeared as if it would veer to the north-east, which would afford a longer journey than if we travelled towards Brighton.

At 1^h P.M. the ascent was determined upon, although it was evident the voyage could not be one of long duration, unless we crossed the channel; but Mr. Coxwell said it would not be prudent to do so unless the balloon were filled, alleging as a reason that excessive elevation is incompatible with great distance, and that to cross the channel it would be necessary to make other and distinct arrangements.

We left the earth at $1^h\ 17^m$ P.M. Within two minutes afterwards we were 3000 feet above the earth, and at $1^h\ 23^m$ we were one mile high; the second mile was passed at $1^h\ 29^m$, the third at $1^h\ 37^m$, the fourth at 2^h, and the highest point was reached at $2^h\ 30^m$, at a height of four and a half miles nearly. At $2^h\ 36^m$ we passed below four miles; the next mile downwards was passed at

$2^h\ 40^m$, and at $2^h\ 46^m$ we were two miles from the earth, which we reached at $2^h\ 50^m$, as presently will be described.

Just before leaving the earth the temperature of the air was 61½°; at the height of one mile the thermometer read 41°; but we had passed up so quickly that it is most likely that this reading was higher than the true temperature; at the height of two miles the reading of the thermometer was 32°; at three miles the temperature was 21°; at four miles, 16°; and at the highest point reached was 12°, which was the lowest temperature we experienced. The results generally confirm the law as found by the combination of all the preceding experiments—viz., that the theory of a uniform decrease of temperature with elevation must be abandoned.

The air was dry before starting, and extremely dry at heights exceeding four miles.

The cumuli clouds were at about 5000 or 6000 feet high. From $2^h\ 15^m$ to $2^h\ 31^m$ I devoted myself, almost entirely, to observing the black lines in the solar spectrum: between these times the balloon was revolving once in five minutes. I succeeded in adjusting the slit of the apparatus to the sun, and kept my eye at the telescope while the balloon completed three revolutions. When the light entered the slit from the sun itself the lines in the spectrum were innumerable; all those I saw before leaving the earth were visible, and many more. The nebulous lines (H) were both seen, and a spectrum a good deal lengthened at the violet end; at the red end A was visible. When the light came from the sky in the immediate vicinity of the sun the spectrum was shorter, but all lines were visible from B to G; on passing from the sun, the spectrum shortened very quickly; and when opposite to the sun, there was no spectrum, in fact no light at all.

A correspondent of yours has expressed a wish that I should include photometric observations in my balloon experiments. I should be happy to do so, if I could with any promise of useful results; but, in fact, I do not know any photometer the use of which yields satisfactory results on the earth, and I fear I should quite fail in the car of a balloon.

For the purpose of learning something of the action of the chemical rays of light, I took slips of sensitized photographic paper, having arranged that similar slips, made at the same time should be exposed at the Royal Observatory, Greenwich, and the amount of coloration in one minute be noted every five minutes, so as to have some simultaneous observations with the experiments I might be able to make in the balloon. The paper in the balloon was exposed to the full rays of the sun, and with this remarkable result, that when above three miles high the paper did not colour in half an hour so much as it did in the grounds of the Royal Observatory in one minute.

At $1^h\ 47^m$, at the height of three miles and three-quarters, the solar-radiation thermometer accidently fell over the car from the sudden displacement of one of my instruments. I should be obliged by any one who should pick up the remains informing me

whereabouts it fell. We were at the time nearly over Reigate; but as the instrument was enclosed in a vacuum tube with a globe at one end, it would not fall very rapidly, and it may have fallen between Tunbridge and Reigate, or south of the line joining these places.

As the Crystal Palace remained some time in view, it was at first expected that the upper current was not so swift as the lower after reaching the height of four miles, and we had determined we were moving directly towards the coast.

Mr. Coxwell continually applied to me for the reading of the barometer, and directed our companion (Mr. I.) to keep a sharp look-out for the sea.

Immediately after we attained an elevation of four and a half miles Mr. Coxwell let off some gas, and said he felt assured there was not a moment to be lost in getting within view of the earth. Mr. Coxwell again let off gas rather freely, so that we descended a mile in four minutes.

At $2^{h}\,46^{m}$ we were two miles from the earth, the barometer reading 21·2 in., when Mr. Coxwell caught sight of Beachy Head, and exclaimed "What's that!" and then the coast through a break in the clouds, and exclaimed, "There is not a moment to spare; we must descend rapidly, and save the land at all risks!" It was a bold decision; but we were in a critical position, and I do not see what else could have been done.

Mr. Coxwell now used the valve with a degree of freedom which would have alarmed any one who had not perfect confidence in his skill.

I was requested to pack up my instruments as quickly as possible, and then to assist in getting ready a large amount of ballast to throw away at the last moment.

On breaking through the clouds we appeared to be already over the water, but as the ground came up to us, or seemed to do so, we found there was land beneath. Mr. I. rendered important service in getting up the neck-lines, and in clearing the ballast for immediate delivery, so as to lessen the violence of the descent.

When orders were given to put out sand we did so simultaneously, which gave a favourable check; and as the lower part of the balloon itself assumed a parachute form, the shock was not so bad as might have been expected. Most of the instruments, however, were broken, owing to their delicate construction and my attention being drawn from them; yet, strange to say, two large glass vessels of air collected at the highest point for Professor Tyndall remained uninjured, as did some bottles of lemonade which Mr. Coxwell had placed in the car.

We descended the last two miles in four minutes, and had we done so less rapidly the land would have been missed altogether, and we must have fallen into the sea. The descent was within half a mile of the railway station at Newhaven.

Mr. Coxwell's decision and expertness were put to as severe a test as it is possible to imagine, and certainly he is entitled to my best acknowledgments. JAMES GLAISHER.—*From the Times, April* 22, 1863.

10. *Scientific Ballooning.*—Ballooning is or ought to be something more than merely going up in the air and coming down again, to be worthy of a special scientific title. And yet show-toy only as the balloon, with very few exceptions, hitherto has been, the skill required in regulating and manipulating its movements, although confined nearly entirely to its upward and downward motions, has not improperly been honoured with a special designation. If we were to see a man lay hold of a gigantic air-bubble and float up from the depths of the Atlantic or the Pacific, we should perceive at once what a strange sort of vessel he had to manage. Long and learned orations would not be required to show that if he could hold it tight and load it with weights, he might cause it to rise or sink, but that its horizontal progressive motion must be at the mercy of the currents of the sea. If the bubble were a long object like a fish, a paddle at each side, or the vibration of a rudder or tail-like part, might control its direction or afford it some proper motion of its own; but every one can see at a glance that a spherical globule could be neither controlled in direction nor artificially propelled.

Now, a balloon is only a gas-bubble confined in a silken case and held fast by a network of ropes, to which weights in the form of bags of sand are attached to balance its lighter gravity with the denser air through which it rises. The equilibrium thus artificially made can be artificially altered; and, instead of rising like a rocket and coming down like a stone, the aëronaut can float up slowly like a cloud, and descend so gently as to press down the tender herbage of the fields without a shock of any kind being felt. It is well to take this simple view because it makes us at once perceive what sort of instrument the spherical balloon really is, and how mad have been some of the wild notions of what it could be made to do.

From the earliest periods men have watched the wonderful flights of birds and wished to imitate them. Some even made the attempt to fly with wings,—John Damian, the Lombard Abbot of Tungland, did so from Stirling Castle to astonish the courtiers of James IV., but "the French Leich" came to grief and astonished himself.

> "He scheure his feddereme thar was schene,
> And slippit out of it full clene,
> And in a myre, up to the ene,
> Amang the glar did glyd."—DUNBAR.

A century after (1617), the worshipful magistrates of Tübingen listened to a lecture from the rector of their grammar school on the art of flying. Fleyder studied his lecture for eleven years before he published it, but prudently never outstepped his theory. A poor monk attempting, however, to put his notion into practice, took a leap from a high tower and perished miserably. As science grew, it was distinctly shown that the prodigious force of the pectoral muscles of birds could never be attained by the muscles of man.

In the fifteenth century an Augustinian monk, Albert of Saxony,

had conceived the idea that since fire is more attenuated than air, and floats above the region of our atmosphere, a portion of such ethereal substance enclosed in a light hollow globe would raise it to a certain height, and keep it suspended in the sky. A couple of centuries later the notion was taken up by the Jesuit, Mendoza, who saw no real obstacle to the application of fire to balloons, and Casper Schott, who thought that the lucid ethereal matter which swims above our atmosphere was alone fitted for aërial navigation, and proposed to fill a hollow ball of wood and lead with it, then with rudder and sails to navigate this strange vessel through the sky. Nothing more practical, however, came of these dreams than did of the bags of dew on which Cyrano de Bergerac despatched his imaginary traveller in his memorable "Comical History of the States of the Sun and Moon." And it was only when Montgolfier in 1782 put the idea in practice, that fire was really known to be able to raise man from the earth, and that aërial journeys were possible.....

On mountain-sides, however lofty the mountain, the influences of terrestrial disturbances and interferences can never be got rid of; and hence the reason why such strenuous efforts have been made to use the balloon for meteorological observations. The attempts that are praiseworthily being made to render useful the important science of meteorology, and to render prognostications of the weather practically useful, as well as to extend our knowledge of the causes of climatal conditions, the effects of changes of temperature, the effects on health and life of the various conditions and states of the atmosphere, and other important hygienic and meteorological topics, will achieve the most important data through these aëronautical explorations. If one could go straight up and come straight down in a balloon through the various currents of air, independent of the influence of their lateral force, the task of gathering facts in the regions of the sky would be far easier than it now is; for all the deviations from a perfect straight line in the balloon's course have to be allowed for, and all the up and down deviations of the balloon's ever vacillating height have to be accounted for in the results. In these respects Mr. Glaisher's latest ascent, briefly noticed by us last week, was the most fortunate, and the balloon's track approached nearer to a straight line than on any recorded occasion; the information, therefore, will be more than usually satisfactory, and will confirm in the best manner his previous deductions.....

The ozonized condition of the atmosphere has also been one of the subjects of these balloon experiments; and on this point we are enabled, by a communication from Mr. Glaisher, to make known for the first time the results he obtained.

"Some of the papers prepared by Dr. Moffatt for the late ascents of last year have been carefully kept from the air, and were used on this occasion. During the last few months E. J. Lowe, Esq., has made many experiments with the view of getting a more uniformly sensitive paper, and he furnished me with some tests for this ascent. In the course of Mr. Lowe's experiments, he has

found more uniformity in the results by using the test in the shape of powder, and he prepared for me two sets of powders made from the formula of 5 oz. of rice starch to 2 oz. of iodide of potassium—the ones marked No. 1 and No. 2, the former made doubly sensitive.

"The aperture was fitted for the reception of six sets of each, side by side, with receptacles for four parcels of flour, which of course would remain white; and thus, by contrast, the slightest tinge of colour in the above tests would be seen. The box was opened when about 100 feet high; at the height of half a mile one set of tests (No. 1) was tinged, and continued to increase in deepness of colour, till I closed the box at $6^h\ 17^m$; at this time Moffatt's paper and Lowe's paper were alike and just tinged, but not so much as 1; Lowe's powder-test was 1; and No. 1, or doubly sensitive, was deeply coloured to 8."

Mr. Glaisher has also forwarded us the following observations on the currents of the atmosphere:—

"On leaving the earth the wind was from the east; at the height of two miles nearly, it changed to the west; a little above three miles the current was from the north-east; five minutes afterwards the current was south-west. At $5^h\ 18^m$, at the height of nearly four miles, the current was west, and continued west at the highest point; at $6^h\ 15^m$ we fell into a south-east current, and for the next quarter of an hour were moving towards London. The wind on the earth was nearly east all the time; when between three and four miles high, we saw smoke move towards the west, then turn, and move towards the east; then change again two or three times, till we could see it following us on our level."

He has further sent us the following interesting notes from his miscellaneous memoranda:—

"The cumuli clouds were at the height of 1500 feet; and when at the height of a mile, the earth appeared dotted with them.

"At the height of one mile there were lines of blue mist crossing each other.

"At heights greater than three miles the sun's image was seen reflected in water.

"At four miles high Mr. Coxwell's pulsations were 98 and mine were 97 in one minute. On the ground our ordinary pulsations are 76 in one minute.

"The sky was of the deepest blue—dark Prussian blue—at the greatest height.

"At heights approaching four miles my heart beat quickly and loudly; not Mr. Coxwell's. At heights exceeding three miles the face was blue.

"At four miles high I had constantly to break ice to get water for wet-bulb thermometer. Surface ice formed instantly."—*From the London Review*, April 11, 1863.

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11. *Scientific Balloon Ascent. The Lines in the Spectrum.*—For the purpose of observing the black lines in the sky-spectrum at different altitudes, and the sun-spectrum if possible, an apparatus

was employed consisting of a prism, a fine adjustable slit, half-an-inch in length, placed in the focus of an object-glass, and a telescope directed to the prism, lent for the purpose by the Astronomer Royal, and is the same apparatus as that used by Professor Smyth on the Peak of Teneriffe. No angular measure was prepared for or contemplated,—only eye-observations and comparison of differences between the spectrum as seen on the ground and at different heights during the journey. A careful examination of the spectrum between the hours of 3 and 4 P.M., before starting, showed B as the boundary at the red end, and a little beyond G at the violet end, when looking at the sky; and when looking at the sun, I could not see quite to H. The lines C, D, double, E, *b*, and F were very plainly shown, with many lines between them. At $4^h\ 20^m$, at the height of about half a mile, a cursory examination of the spectrum showed a close correspondence with that on the earth, showing lines B to G, but the extreme lines with, I thought, less distinctness; at $4^h\ 30^m$, at the height of about one mile, the spectrum was bright, but less in length, both at the violet and red ends. The line G was quite the limit, and I could not see B; and C was doubtful. At $4^h\ 35^m$, at the height of about two miles, G was lost entirely, and the violet was dull; I could see F and D, but not beyond. At $4^h\ 42^m$, at three miles high, I lost violet entirely, and could not see F. At $4^h\ 46^m$, between three and four miles high, the spectrum was very short. I could see from a little beyond D to E; I think *b*, but not F. At $5^h\ 10^m$, at four miles high, I could not see any spectrum, excepting a little yellow tinge. At $5^h\ 30^m$, at four and a half miles high, I saw no spectrum and no colour. At $5^h\ 43^m$, at the height of three miles, on descending, there was no spectrum; I opened the slit, and saw a faint tinge of colour only.

Bearing in mind that the time available for this class of observations in the balloon is inadequate to take correct drawings, I only attended, with as much care as the shortness of the time admitted, to the general appearance, the limiting lines of visibility at both ends of the spectrum, and very little to the thickness, or number, or definition of the lines themselves. The general result is, that no lines were lost from the spectrum, excepting those by the shortening of the spectrum itself; but it must be borne in mind, that although it was very light with us, yet the sun was low, and the shortening of the spectrum itself may be attributable to the want of light. For this class of experiments, it will be necessary to have a balloon ascent starting either in the morning or about noon, to compare with the preceding observations, and to determine whether the spectrum does really shorten with elevation, as well as to determine whether any lines are lost by passing into a less dense atmosphere. JAMES GLAISHER.—*Athenæum*, April 11, 1863.

12. *Climate of Turin, Piedmont* (lat. 45° 4′ N., long. 7° 40′ E.). Barometer Mean of 74 years, 1787–1860. Thermometer Mean of 107 years, 1754–1860.

	Barometer.				Thermometer.			Thermometer.	
	Mean.	Maximum.	Minimum.	Range.	Mean.	Maximum.	Minimum.	Average maximum.	Average minimum.
	inches.	inches.	inches.	inch.	°	°	°	°	°
January	29·078	29·504	28·519	·985	32·6	61·9	0·5	48·7	16·4
February	29·069	29·486	28·518	·968	38·1	71·2	0·0	54·3	24·1
March	29·051	29·478	28·465	1·013	47·1	77·0	11·7	64·8	29·7
April	29·042	29·380	28·562	·818	54·5	83·7	23·6	72·4	37·1
May	29·113	29·371	28·696	·675	63·1	91·4	36·5	80·2	45·6
June	29·166	29·371	28·838	·533	70·3	95·4	38·7	87·8	54·0
July	29·176	29·398	28·891	·507	74·7	98·4	48·9	89·9	58·8
August	29·193	29·398	28·838	·560	73·1	98·4	46·6	87·4	57·6
September	29·175	29·450	28·776	·674	65·7	94·7	36·3	81·3	49·2
October	29·113	29·486	28·608	·878	55·9	81·7	29·3	72·1	39·3
November	29·069	29·442	28·527	·915	43·4	72·5	18·5	49·8	21·3?
December	29·069	29·486	28·519	·967	35·6	59·0	3·0	49·7	21·3?
	29·109	29·437	28·646	·791	54·5	......	......	69·9	39·8

Bullettino Meteorologico dell' Osservatorio del Collegio Romano, of 31st August, 1862.

NOTICE TO MEMBERS.

An Ordinary Meeting, at which papers will be read, will be held on Wednesday, June 17, at 7 o'clock; which will be followed by the Annual General Meeting, at which the Report of the Council will be read.

The four Numbers of the 'Proceedings' published for the last Session are to be obtained from Messrs. Taylor and Francis, for Nine Shillings.

Members are requested to forward Notes and Notices for insertion in the 'Proceedings' to one of the Secretaries.

[*Price Four Shillings.*]

Vol. I.] [No. 8.

PROCEEDINGS

OF THE

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1863, JUNE 17.

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BRITISH METEOROLOGICAL SOCIETY.

This Society was established in the year 1850, for the encouragement and promotion of Meteorological Science.

It consists of Members and Honorary Members.

Every person desirous of admission into the Society must be recommended by at least Three Members, of whom one must certify to his personal knowledge of such Candidate.

Candidates may be proposed at a Council Meeting; but the ballot must take place at an Ordinary Meeting. One Council or Ordinary Meeting must intervene between the nomination and the day of Election.

There is no Admission Fee. The Annual Contribution is £1; due on January 1. The Composition Fee is £10.

Persons eminent in Meteorological Science, not permanently residing in this country, are eligible as Honorary Members.

The Council of the Institution of Civil Engineers allow the Society to hold their Meetings at the Institution, No. 25 Great George Street, Westminster, S.W.; and to receive letters there.

Six Ordinary Meetings are held during the Session, which commences in October and terminates in June, at which Members can introduce their friends.

Papers accepted for reading at the Ordinary Meetings are published entire or in Abstract in the 'Proceedings' of the Society, which are issued as soon as possible after each Meeting, *and of which a copy is sent to every Member of the Society.* The 'Proceedings' also contain Notices of Books and Memoirs, descriptions of New Instruments, and other Meteorological News.

Daily observations are made, for the most part by Members of the Society, at about 60 different stations, which are forwarded monthly to one of the Secretaries, by whom each reading is examined and collated with readings made in adjacent stations. Their means are taken; and monthly results deduced, which are prepared for press and sent to the Registrar-General, to appear simultaneously with his 'Quarterly Report of Births, Deaths, &c.' A copy of each 'Quarterly Meteorological Report' *is sent free to every Member of the Society.*

Copies of printed results of Meteorological Observations or Papers are from time to time received by the Society for distribution; and *are forwarded free to Members.*

The 'Proceedings' of the Society are published and sold by Taylor and Francis, Red Lion Court, Fleet Street, E.C.

The Society possess a Library, which is available to Members. The late President, N. Beardmore, Esq., has kindly received it in his rooms, 30 Great George Street.

The address of the Treasurer, H. Perigal, Esq., to whom subscriptions may be paid, is 57 Warren Street, Fitzroy Square, W.

Gentlemen desirous of joining the Society may communicate with either of the Secretaries.

1863, June 17.

JAMES GLAISHER, F.R.S., Dartmouth Place, Blackheath, S.E. } *Secretaries.*
CHARLES V. WALKER, F.R.S., Fernside, Redhill

PROCEEDINGS

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BRITISH METEOROLOGICAL SOCIETY.

VOL. I.] 1863, JUNE 17. [No. 8.

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William Sowerby, Esq., Royal Botanic Gardens, Regent's Park;
Charles Stenning, Esq., Solicitor, 3 Basinghall Street, E.C.; and
Lt.-Colonel Alexander Strange, F.R.A.S., 18 Walton Place, Hans Place, S.W.;
were balloted for and duly elected Members of the Society.

Sir Charles T. Bright, C.E., F.R.A.S., &c., 12 Upper Hyde Park Gardens, W.; and
Charles Greaves, Esq., C.E., Old Ford, Bow;
were elected Auditors.

XXXVI.—*On the Theory of Vapour-pressure.* By JOHN CHARLTON BLOXAM, Esq.

THE sixth Number of the 'Proceedings' contains an article which calls in question Dalton's theory of vapour, and its application to the aqueous vapour of the atmosphere. As there is no question of the importance of the subject in all meteorological inquiries, Professor Lamont's objections call for discussion: every meteorologist must wish to know whether Dalton's theory is really overturned by the Professor's experiments and reasoning.

It may be very *desirable* "to come to a definite decision as to what is the relation in which the aqueous vapour existing in the atmosphere stands to the atmosphere itself;" this is no doubt a great desideratum; but the article under view effects very little in the way of supplying the deficiency. The aqueous vapour probably does not form an atmosphere totally independent of, nor absolutely dependent upon, the air: the vapour is probably not *merely* mechanically mixed with the air; it is probably not chemically combined with the air; the connexion subsisting between vapour and air, as the two exist together in the atmosphere, may be dependent upon electric conditions. Neither Dalton's theory nor Lamont's theory asserts either the positive or the negative view of either of these propositions absolutely. It is to be remembered that Dalton's "theory" is not merely a *theory*: the *laws* he announced are laws deduced from, and clearly indicated by, experiments carefully conducted; and he deals with the physical results of the combination, rather than with the law by which the combination is effected. No one, perhaps, will at present venture to pronounce on the essential nature of the combination. The three "principal results" stated by Lamont are positive results obtained experimentally; and the Professor's experiments do not appear to invalidate either one of them; they tend, indeed, to their confirmation. "As to the mutual relations subsisting between vapour and air, when they are simultaneously present in the same space, the experiments (of Dalton) afford no information." This is perhaps not quite a correct statement; but what are the mutual relations indicated by the Professor's experiments? They seem to be nothing more than this:—if the portion A of the space A B is occupied with air, and the portion B with vapour, whatever the elastic force of the air may be under this arrangement, the amount of that force will be diminished by withdrawing the vapour from

B, and allowing the same air to occupy the whole of the space A B $\boxed{\begin{array}{c}A\\ \hline B\end{array}}$. The interpretation that Dalton gives to the second of the three propositions is, that, when air and vapour are mixed together in the manner (though perhaps not in the same degree) that obtains in the atmosphere, neither of the two influences the *elastic force* of the other: or, more correctly, this is the result obtained by experiment: he gives no such interpretation as that "no mutual relation whatever existed between vapour and air;" he would doubtless have acknowledged such mutual relation as the diagram above refers to. Dalton's theory does not imply that the atmospheric vapour *is* "sustained in equilibrium by itself alone;" but, that it *can* attain to a state of equilibrium by virtue of *its own gravity* only; and its tendency to acquire equilibrium as an independent agent helps to determine its movements, and to regulate its quantity in any particular locality. The third proposition "properly declares that there is indeed always a tendency to a normal relation," in so far as that each of the constituents has always a normal (though constantly varying) condition belonging to it; but this does not ignore the fact that neither the normal conditions nor the normal relation can ever be reached, owing to the law that one of the two bodies is perpetually being exhausted at one point and reproduced at another, which necessarily leads to this one being always in motion and never in equilibrium. It may be strictly true, or it may be true in a limited sense, that "a mass of vapour and a mass of air, placed in communication with each other, mutually preserve a state of equilibrium without the vapour penetrating into the air, or the air into the vapour;" but this is not "contradictory to Dalton's theory." Dalton states that the two constituents do not readily mix, spontaneously: the Professor contrives by artificial means to counteract (or impede) the natural tendency to mixing; he endeavours to, and professes to, suspend entirely that process of mixing which actually and habitually does take place, and which it has been supposed must sooner or later arrive at complete intermixture, provided the two bodies are left to their own spontaneous actions; but Dalton's theory does not gainsay the possibility, nor imply the impossibility, of doing this. Dalton's theory is not adverse to the proposition that, if air be preserved unmixed in the space A, and vapour be preserved unmixed in the space B, the elastic forces of these two bodies will press one upon the other. It is quite clear that, whilst each maintains its own

separate position, each must press against the other where they come in contact, just as it does against the other retaining surfaces.

The "essential error" that is supposed to be discovered in "Dalton's laws" seems to be this, viz., he is supposed to have overlooked the fact that, if a perfectly elastic body is introduced into a circumscribed mass of elastic air, the elastic force of the elastic air will be increased in proportion to the diminution of space afforded the air to expand in; but there is, apparently, no ground for assuming such an error: Dalton was no doubt quite aware that under such circumstances the two bodies would necessarily "exert a mutual pressure upon one another." It is clearly quite a matter of course that the elastic force of the body occupying the space B (or the bottom of the globe "K") would be transmitted through the elastic body A to all the surfaces retaining A; and one of these surfaces would be the surface of B in contact with A: action and reaction would be one and the same as regards A and B. It is stated, "according to the theory of Dalton, a rise of temperature from 67°·8 to 126° would, if the vapour had not penetrated in the tube up to the drop of quicksilver, move the latter as before 12·224 inches." *The essential error* seems to be involved in this statement, because it does not appear that Dalton's theory does in fact involve any such result: the pressure brought to bear upon the drop of quicksilver must surely be the sum of the pressures of the air and of the vapour contained in the globe K. According to Dalton, if as much vapour be forced into a limited space as can exist in that space in the form of vapour, the quantity that can so exist will not be diminished by forcing air into the same space with the vapour, *provided* the two be intermixed in the manner they admit of: this is the grand result and main principle of Dalton's doctrine; and there is nothing in Professor Lamont's experiments or reasoning that is opposed to it. If vapour is slow in diffusing itself through the air, and a portion consequently remains unmixed, this portion will then be subjected to the pressure of the air; and it may then be condensed, although it would not have been so condensed by its own pressure.

A mass, or layer, of vapour may be imagined as held in the grasp, as it were, of the atmosphere; and it would then comport itself the same as if it were enclosed in an elastic bag; it would be subjected to the pressure of the atmosphere. It is probable that masses of vapour often exist in the midst of the atmosphere,

mixed with a comparatively small proportion of air: it would, then, not press upon the atmospheric vapour beneath, in the same manner that it would do if diffused equably through the atmosphere; it would press against the surrounding atmosphere, and the atmosphere would press upon it: the vapour-pressure thus transmitted through the atmosphere would not be distinguishable, at the surface of the earth, from the air-pressure; we should not be able to detect the vapour existing in this state by any of our instrumental aids, at the surface of the earth. The Dalton law is correct; but a false interpretation has been given to it by the inventors of hygrometers. The hygrometer detects that portion of the vapour-pressure only which arises from the vapour diffused through the air; and the quantity of vapour in the atmosphere is probably always considerably greater than the vapour-pressure indicates: the air-pressure must be, to the same extent, less than the estimate. This may lead to the conclusion that the atmospheric vapour is a more powerful agent in giving motion to the atmosphere than it has hitherto been supposed to be. Pure vapour in the midst of air is subjected to foreign pressure, and it is not governed by its own laws; if it be mixed with a comparatively small proportion of air, it will be placed, more or less, in the same predicament. If it have expanded itself fully through the texture of the air, it will then be subject to its own laws; the pressure it then exercises is the pressure of itself, and of the whole of itself.

XXXVII.—*Note on the Theory of Vapour-pressure.*

By G. B. Airy, Esq., F.R.S., Astronomer Royal.

It strikes me (I am writing without any of the original works at hand) that the supposed error which Lamont's experiments were intended to correct is not exactly that upon which Mr. Bloxam's attention has been fixed. On the accuracy of Dalton's experiments, under the circumstances in which they were made (confirmed as they have been by Regnault's), there can be no doubt. I apprehend that they amount to this:—"In a limited space, of such a form as is very favourable to the motion of masses or particles of gas, the dry air and the aqueous vapour coexist through the whole space, each exerting the same elastic pressure as if the other was not there." In ordinary quotation, this law has been cited to some

such effect as the following:—"In any spaces, we may consider separately the law of distribution of the vapour as that of an elastic gas supposing no air present, and the law of distribution of air as that of an elastic gas supposing no vapour present; and we may represent the actual state by combining these two gases in the densities thus indicated." For instance, the hygrometer showing a great density of vapour near the ground, it has been supposed that the density of vapour in every stratum above it can be computed from that lower density by the same laws as if vapour were the only gas above the ground, disseminating itself by the ordinary laws of gaseous dissemination. I do not know whether any writer has expressed the principle so broadly as I have stated it; but I think that some have come very near to it, and I have no doubt whatever that it is the tacit idea which guides many meteorologists.

It is against this idea of *dissemination* that Lamont's experiments are directed. He does not dispute that, where air and vapour are mixed, Dalton's law holds truly; but he asserts, and shows amply from experiments, that the *dissemination* does not at all take place according to the law of simple elastic gases. A gas, if no other gas were present, would with great rapidity disseminate itself into every chamber connected with the place where it is first set free; aqueous vapour, there is no doubt, would do so if it were alone: but *aqueous vapour, combined with air, will not do so*; it will long remain in one place, as if the mixture of air and vapour produced viscosity. This is what Dr. Lamont shows; and I do not think that Mr. Bloxam disputes the experimental fact.

XXXVIII. *On the Hurricane of May* 1862, *at Highfield House and Newark*. By Edward Jas. Lowe, Esq., F.R.A.S. &c.

This hurricane was accompanied by a thunder-storm more or less spread over the centre of England, where in numerous places there was great devastation caused by the hailstones, but not by the hurricane itself, except near Newark. The following brief particulars will perhaps be important in the investigation of a hurricane so destructive as the one I am about to describe.

Peterborough.—Near here the direction of the storm was from S. to N.E.; here, for one and half miles in width, the crops were devastated by huge hailstones of 3 inches long, 2 inches wide, and ½ inch thick. As a matter of course, much glass was broken.

Oundle.—The crops were destroyed and the windows broken by hail.

Whittlesea.—Ditto. The storm began at 3 P.M., and lasted till 4 P.M.; wind S., rough.

Eye.—Ditto. The storm from 3 to 4 P.M.

Thorney.—Ditto.

Crowland.—Ditto. The storm began at 4 P.M., from S.E. Hailstones 4 to 5 inches in circumference.

Leeds.—Ditto.

Newark.—Ditto.

Whittington (near Chesterfield).—Ditto. Hail commenced at $4^h 45^m$ P.M. The wind W., veering to S., and then to E., and by $5^h 45^m$ P.M. again W.

Buxton.—The storm commenced between 4 and 5 P.M.; and by $5^h 45^m$ P.M. the darkness was too great to allow of reading or working, and gas was lighted. Heavy rain, but no hail. The lightning was first *blue*, then *peach*, *mauve*, or *rosy blue*.

Whaley Bridge.—Sudden, fierce S.W. gusts, and a deluge of rain.

Walton (five miles from Wisbech).—A sudden S.E. gale for a few minutes at $4^h 50^m$ P.M., the sky being very thick in the W.

Middle-level Sluice.—At $5^h 30^m$ P.M. there was a strong S.S.E. wind (with lightning, thunder, and large rain), which moderated at 6 P.M., going to the N.; strong S. wind till 7 P.M.

Wisbeach.—At $6^h 15^m$ P.M. the darkness so great as to render it almost impossible to see close to a window; wind S.W.

Lea (two miles S. of Gainsborough).—Continuous thunder from 4 till 6 P.M., at first over Lincoln, at 5 P.M. over Newark (where a dark lurid cloud rested), and after 6 P.M. over Worksop. The day was hot till 6 P.M., when a sudden W. breeze sprung up, and the weather rapidly became colder. No rain or hail fell.

Radborne (five miles N.W. of Derby).—The storm commenced at $4^h 30^m$ P.M., and lasted till 6 P.M.; the storm came from S., bearing E. The course of the storm was from Burton. Heavy rain; but no hail, and the lightning never overhead.

Whittington (three miles from Chesterfield).—The hail commenced at $4^h 45^m$ P.M., with W. wind; some stones were 4 inches in circumference, and $1\frac{1}{4}$ inches in diameter, weighing from $\frac{1}{4}$ to $\frac{1}{2}$ an ounce, and breaking much glass.

Chesterfield.—No hail.

Leeds.—The hailstones were here 7 inches in circumference.

Wath (near Rotherham).—The thunder commenced at $5^h 15^m$

P.M., and became continuous at $5^h 45^m$; at $6^h 30^m$ very dark, a dense black cloud extending from S.S.E. to W.S.W.; wind S.W. The storm was over at $7^h 15^m$ P.M.

Silloth.—A storm at 10 P.M.

Shiffnall (Shropshire).—No thunder, but incessant rain, with N.N.W. wind.

Ventnor.—Incessant rain, but no storm.

Clayton.—Ditto.

Hurstpierpoint.—Ditto.

Clifton.—Ditto.

Sandgate (Kent).—No storm.

Tunbridge.—Ditto.

Ramsgate.—Ditto.

Gloucester.—Ditto.

Byfleet.—Ditto.

Barnstaple.—Ditto.

Aldershott.—Ditto.

Kington (Herefordshire).—Incessant rain, and unusually dark, but no storm.

It is worthy of remark that on the previous evening a violent thunder-storm was raging in the Isle of Wight, and extending all the way to London, also at Hurstpierpoint, Byfleet, Aldershott, Tunbridge, Lincolnshire, Leicestershire, Nottinghamshire, Derbyshire, Yorkshire, and Clitheroe, accompanied with large hailstones and *rose*-coloured lightning. At Highfield House there was continuous thunder all the afternoon in S. and S.E., from storms following each other in rapid succession in a S.W. current. The wind changed at 4 P.M. from N. to W.; at $7^h 50^m$ P.M. a thunder-storm in a S.S.E. current commenced passing over, the lightning exceedingly vivid and very blue in colour. At 8 o'clock, for two minutes, there was a hailstorm, with stones of a conical form and as large as nuts. Above an inch of rain fell. In half an hour this storm had passed over to N.; but there was much lightning and heavy rain all night. The similarity, in many respects, of this storm with the one next day makes it desirable to place this brief report on record.

We shall now pass to the memorable 7th of May, a day that must long be remembered in Nottinghamshire—memorable for the Newark hurricane, and for the violence of the thunder-storm in the neighbourhood—particularly striking from the *night-like* darkness, the great size and curious forms of the hailstones, and on account of the magnificence of the colour of the lightning.

At Highfield House, the morning was fine and sultry; about noon thunder was audible in the S.E., and again at 3 P.M. continuously in S. and S.E. At $2^h\ 30^m$ the temperature in the shade had risen to 73°·6, with a W. wind, but with clouds whirling round in all directions; a low current carried the broken nimbi rapidly from the W., whilst at the same time the storm-cloud was approaching in a S.S.E. current.

At $4^h\ 30^m$ P.M. the temperature had fallen to 60° (a descent of 13°·6 in two hours), whilst the wind had risen to half a gale. At this time low, long-rolling, distant thunder in S.E. gave unmistakable signs of an approaching storm of great magnitude. The sky gradually became blacker and blacker, until at 5 o'clock it was darker than I had ever before seen it (except within the central path during totality of the total solar eclipse of July 1860). A book could scarcely be read at a window, nor away from one could the time be ascertained by a watch. The darkness had very much the appearance that nature puts on during a totally eclipsed sun; all near objects had a yellowish glare cast upon them, and the landscape was closed in on all sides at the distance of half a mile by a storm-cloud wall. The rain, which fell in torrents, did not fall in the ordinary manner; it was swept along the ground in clouds, like smoke. The lightning was also singular in character: four or five flashes followed close upon each other in rapid succession, then a brief pause, and then four or five more. The colour of the lightning was more beautiful than I had ever before seen it, being an intense tint of *bluish red*, approaching *rose*, all the flashes being of the same colour. The brilliancy of the lightning was very great—too great to look at without pain to the eyes, except when reflected on white paper. The colour surpassed all known colours, as much as ultramarine surpasses ordinary blue.

The wind now veered to nearly S.S.E., taking the storm's direction. At $5^h\ 35^m$ P.M. the temperature had descended to 51° (a fall of 22°·6), the wet-bulb thermometer being also 51°, and the air completely saturated; the rain was, however, less heavy. The storm had mostly passed to the N.W., and the sky, more especially in the N.E., was considerably lighter.

At $5^h\ 50^m$ P.M. the wind veered to W.N.W., and the temperature commenced rising.

It is worthy of remark that the barometer was almost stationary, being no doubt held up by the great coldness of the storm in comparison with the surrounding air. This I have repeatedly known to be the case with thunder-storms. In above five hundred

storms recorded from this place, there is a large majority in which the barometer has risen on the storm approaching.

At 6 o'clock the temperature had again risen to 53°·3, the wet-bulb thermometer being 52°·5, and the wind W., the force having moderated from a pressure of 9 lbs. on the square foot (at 5 P.M.) to a pleasant breeze.

The storm had passed over us in a S.S.W. current, moving slowly across a violent W. wind.

At 6 o'clock the clouds were in a S.E. current, except in the S.W., where they were in a N.W. current. The nearest flashes were one and a half miles off.

At 6^h 15^m P.M. the storm was evidently sinking more westerly, the course having become S.E., and then E.S.E.

At 7 o'clock there was again distant thunder in the E.

At 7^h 15^m P.M., flying scud, in a W.N.W. current, moved with fearful rapidity—faster than I have ever seen it either before or since, passing from overhead a distance of 45° (*i. e.* to altitude 45°) in 42 seconds; at the same time a more lofty current carried clouds slowly from the S.E.

At 7^h 40^m P.M. lightning in the N.E., where the sky was again black.

From 8^h 40^m till 8^h 55^m, a gale, after which the wind moderated. Several trees were uprooted, and the ground was quite white (as if from a snow-storm) from the vast amount of bloom torn off the apple-trees.

The amount of rain was not excessive, viz. 0·665 of an inch.

Severe as this storm was at Highfield House, it dwindles into insignificance when compared with its violence near Newark, where it was accompanied by a hurricane and hail-storm similar to those occasionally witnessed in India. It is scarcely possible to imagine any destruction more complete than that effected by this fearful storm; but fortunately its ravages were confined within narrow limits. The photographs taken next day, which accompany this paper, will give some idea of the devastation caused.

The hurricane seems to have commenced at the village of Barnby, where a small barn was thrown down. South of this place no damage was done. After proceeding a mile, its force suddenly increased considerably; and just before reaching Coddington, its course crossed a farm-house and buildings, which were unroofed. It then passed over several fields, tearing up the hedges. One of the fields was ploughed in ridges for potatoes;

these ridges had entirely vanished, and the field was left perfectly level. As it crossed Balderton Lane, it unroofed a farm-house, and threw down the farm-buildings, uprooting two enormous oak-trees. [Two views of this farm-house and of these gigantic prostrate oaks, were enclosed.] A quarter of a mile further, it unroofed the house of the head keeper of Mr. James Thorpe, of Beaconfield, breaking nearly all the windows, the hail-stones having in many instances been driven through the glass, cutting out a smooth hole, without cracking the window-pane. The spout of this house —one too heavy for a man to lift—was carried a hundred yards (by measurement). A perfectly sound tree, about 60 feet high and 5 feet 10 inches in circumference (where broken off), was snapped asunder 4 feet from the ground, and the tree itself carried 29 yards through the air. Although snapped off suddenly, it shows the circular motion of the storm, as the wood is twisted to the very heart of the tree. [A stereoscopic view of this tree was enclosed, which shows the twist of the wood.] Near here a man was lifted off the ground and carried 20 yards, being finally deposited in a hedge.

From this point to Mr. Thorpe's house were many fine trees, all of which were torn up by the roots or broken off. About 30 or 40 yards from the house, the hurricane divided, as the house itself is intact, and also the trees in its immediate neighbourhood from S. round by E. to N. (a lilac-tree not having its blossoms damaged), while, on the western side, out-buildings are unroofed and in some cases destroyed, the large garden-wall thrown down, the green-houses smashed, the fencing round the plantations broken off and carried into the fallen timber, and a heavy plank of wood lifted off the ground, snapped into two, one-half lodging at the top of a building, and the remainder carried over it into the kitchen-garden. A few yards beyond the house the divided gale reunited; its course now passed through a wood, where everything in its path was destroyed, then, proceeding onwards a mile and a half, reached Winthorpe, doing considerable damage; but a little further its fury became exhausted.

The greatest violence was restricted to three miles in length, its extreme breadth being from 100 to 150 yards, except near Coddington, where for a short distance it was much broader. The course was from S.S.E. to N.N.W., being almost a straight line. From Barnby to Balderton the ground rises; from Balderton Lane to Mr. Thorpe's keeper's house the ground falls rapidly, and from this point it is tolerably level.

The photographs [that were enclosed] give a good idea of the violence of the hurricane; and the specimen of the glass, with a hole punched out by a hailstone, will further illustrate the violence. I had much better specimens, but, unfortunately, by the carelessness of the servants of the Great Eastern Railway, most of the specimens were destroyed. Mr. A. Stevenson, of Tynemouth, who was visiting Mr. Thorpe at the time, was an eye-witness of the storm, and from him I derived the following valuable information.

"At $3^h 30^m$ P.M. there were mutterings of thunder. From 4^h P.M. to $4^h 30^m$ P.M. heat oppressive. About $4^h 45^m$ and till 5^h P.M. exceedingly large and curious hailstones fell; they were of four shapes.

"1st, hemispherical, clear like ice, except an opake central point from which semiopake lines radiated along the base. Only a few of these fell.

"2nd, flattened spheres, semiopake, with hard white centre, thinner at the axis than at the circumference. More numerous.

"3rd, opake, pear-shaped. Numerous.

"4th, ordinary, circular, opake, and softish.

"On the falling of these stones, the air became chilly. At about 3 minutes past 5, on looking out of a window, Mr. Stevenson's attention was attracted by seeing a pony, closely followed by sheep and cattle, rushing in terror and at great speed from S.S.E. Opposite the house the pony stopped and looked back, and then started off at still greater speed, as if pursued. In the direction from which the cattle came, the sky was quite obscured by a strange dark wall of cloud which was approaching; then the air was filled with a large quantity of hay and straw, followed by clouds of the blossom of the horse-chestnut and small twigs; then at once, with a roar which is indescribable, came a furious blast, which seemed as if it would sweep the land of all which stood on it. Great trees went down before it, torn up by the roots, levelled as if by a sudden blow. The impression was, that the house must be swept away. This continued rather more than a minute, and was accompanied by gleams of lightning so frequent as to seem continuous. When it passed, there was a torrent of rain, with extremely vivid lightning. The gardener, who was out in this storm, says that he observed it hurling down the trees to the south of him, passing by, and then throwing them down in the north, and that from where he stood, he considered that in two minutes everything was destroyed within his view, which extended a mile and a half."

My brother (Capt. A. S. H. Lowe), who was out at drill with his regiment a mile from Beaconfield, describes the storm-cloud,

seen from this distance, as tapering to a point, like a waterspout, and being exceedingly black. He measured many hailstones $1\frac{1}{2}$ inch in diameter, and some few larger. He says the hail fell with great force, yet not sufficiently violent to pass through glass without cracking it; it was therefore the force of the hurricane that propelled them, like bullets shot from a rifle. These bullet-like holes were drilled through the windows both on the east and west side of the house, showing the circular movement of the air. From the keeper's house I had a number of these panes of glass cut out of the windows, in order to preserve them. I also procured the circular pieces of glass that had been punched out, and which were lying about the floors of the rooms.

It is interesting to observe that, whilst at Highfield House there was a W. gale of 9 lbs. pressure on the square foot, at Beaconfield the hurricane was in a S.S.E. current; and that whilst the hurricane was passing Beaconfield the wind at Highfield House suddenly veered to S.S.E., and on its conclusion moved back to W.N.W.

Probably these gales combined; and, the southerly one being the more powerful, a rotation was caused, moving in the direction contrary to those of the hands of a watch. This was apparent, on examination, not only from the direction of the twist of the wood on the snapped-off trees, but also from an avenue of chestnuts situate on the extreme E. edge of the hurricane, all the torn-off boughs lying on the S. or storm side, and *carried back beyond the level of these trees.* The dividing of the hurricane at Mr. Thorpe's house was a further proof of the rotation being retrograde; for no doubt the substantially built house and stables to the W. of it saved the trees, yet those left standing were such as would have received no protection if the force had either been exerted in a straight line, parallel with the path of the gale, or *direct* in its circular movement. As it was, the lull to the E. of the house *close to* was so great that a lilac-tree in full bloom had not its blossoms damaged.

A number of photographs were taken from "Dr. Hill Norris's dry plates." These plates had travelled with me to Spain in July 1860, and being unused there, the boxes were first opened in May 1862, and the plates found in excellent condition, as a reference to the photographs themselves will testify.

The fall of 22°·6 of temperature in two hours at the Highfield House Observatory (twenty miles away) was no doubt owing to this disturbance.

XXXIX. *Aurora Borealis seen on March 21st, 1863, at the Beeston Observatory.* By EDWARD JAS. LOWE, Esq., F.R.A.S. &c.

THE evening had been cloudless, with faint aurora borealis.

At $7^h\ 57^m$ Greenwich mean time, a fine low auroral arch, with an intensely black *dark segment*, was rapidly formed, extending along the horizon from 3° W. of the moon to nearly under the principal stars in the Great Bear, the altitude of its centre being 12°, its position or horizon about 10° W. of Polaris, and the luminous apex 1° broad, and much confused on the upper edge. The star α Cygni shone through the dark segment, but no other.

$7^h\ 58^m\ 45^s$, coruscations suddenly sprung up; they were numerous, colourless, confused, and reached the altitude of Cassiopeia.

$8^h\ 8^m$, very bright, extending to altitude 43°, the dark segment broken up by the base of the coruscations commencing within the arch. A small luminous arch was now formed, having its centre or horizon 10° E. of Polaris, and reaching an altitude of 14°.

$8^h\ 22^m\ 40^s$, a bright coruscation, just W. of Cassiopeia, extending to the zenith, which lasted two minutes (*i. e.* to $8^h\ 24^m\ 40^s$). This moved *westerly* 1° in $1^m\ 50^s$.

$8^h\ 24^m$, another conspicuous coruscation in N.N.E., which travelled *easterly*, but more slowly, moving 1° in $2^m\ 30^s$ (this was evidently more remote). There were many other confused streams; and the phenomenon had a cloud-like appearance; the clouds luminous, instead of opake and black, so common with brilliant auroræ.

$8^h\ 28^m$, no coruscations. A luminous patch W. of, and slightly below, altitude of Cassiopeia.

$8^h\ 33^m$, dark segment again visible, and a bright patch of light at its apex, N. of Cassiopeia.

$8^h\ 33^m\ 44^s$, a meteor, at first only equal to a fourth-magnitude star, but increasing to that of the first magnitude, fell from ξ Persei to α Arietis, at first of the *colour of gaslight* (by which it was compared); but on passing into the aurora, it became *remarkably red.* Disappeared at $8^h\ 33^m\ 44^s{\cdot}7$.

$8^h\ 35^m$, aurora suddenly almost disappeared.

$9^h\ 34^m\ 45^s$, a solitary stream, 1° wide and colourless, sprung up. The base was 5° below ϵ Tauri, and it extended in a straight line to about right ascension $5^h\ 25^m$, N. declination 25°.

$9^h\ 37^m\ 50^s$, the S. edge just touched α Tauri.

$9^h\ 39^m\ 15^s$, the N. edge just leaving α Tauri.

$9^h 40^m 15^s$, S. of α Tauri, crossing ζ Tauri, and reaching to right ascension $5^h 50^m$, N. declination 25°.

$9^h 43^m$, the stream vanished.

This stream always pointed to α Geminorum, and it moved westerly at the rate of 1° in $1^m 25^s$.

I have often noticed the beams of aurora travelling W. on the W. half of the phenomenon, and E. on the E. half; also that the speed is more slow E. than W., the W. portion apparently nearer to us.

Aurora borealis was seen amongst cloud at $10^h 40^m$ P.M. on the 19th. There had been a W.N.W. gale on the 20th, commencing at $10^h 40^m$ A.M. and lasting till $5^h 10^m$ A.M. of the 21st, being most violent from $10^h 15^m$ P.M. till 11 P.M. of the 20th, reaching 12 lbs. pressure on the square foot.

XL.—*Notes on the Climate of Belize, British Honduras*, 1863, *February, March, April.* By the Hon. SAMUEL COCKBURN.

VERY little rain has fallen during the month of February 1863, and the tanks begin to get dry. If, as is said to be usual, we should have no rain till May, the scarcity of water will be deeply felt, as that from the Belize river is not drinkable, and there are no wells, an attempt to bore an artesian well having failed after several fruitless efforts. A descent of about 40 feet through the alluvium was effected; but no good water appearing, the design was abandoned.

There was a slight shower of hail (about the size of a pea) on the 9th, at 5, and again at 11 A.M., the sun shining brightly. It came on with a short passing squall and pelting rain from the N.

P.S. March 17th.—Since the foregoing, a most devastating fire has occurred here, by which one-half the town of Belize is laid in ashes; from 400 to 500 houses have been destroyed, and many poor families totally ruined. It occurred at 3 o'clock on the morning of the 10th; and the buildings, being all of wood, went off like tinder, the smouldering embers continuing to flicker for two days, keeping the people, houseless and penniless, in constant alarm.

Contrary to all expectations, we have had variable weather and a proportion of rain in the month of March; but the great feature of the month is the calamitous fire which broke out on the morning of the 10th, and laid one-half of the town in ruins.

This has caused a hiatus of several days in my observations, so that the sheet for the month cannot be considered a fair average; and as nobody else, that I am aware, takes regular and continuous notes, I could not refer to any one to fill up the blanks.

As is usual after all great fires, some heavy showers fell on the 12th; but, my pluviometer and some other instruments being destroyed, I could make no note.

There is nothing worthy of remark in the month of April. Continued dry weather, getting gradually warmer every day, but modified by a cool and steady sea breeze. No sickness to speak of, beyond colds and fevers, induced by exposure from the fire.

XLI. *The Antagonism of the Polar and Equatorial Air-currents, exemplified illustratively by the unseasonable Storm, in Western Europe, of the* 18*th and* 19*th of May* 1863. By Colonel Austen. Communicated by H. S. Eaton, Esq., Librarian.

It will be apparent to any one, who compares the accompanying map of the United Kingdom and the western coasts of France and Holland with the tabulated weather-records hereto appended, that the polar and equatorial air-currents intermingled their opposite elements of cold and heat, and of positive and negative electricities, *along the dotted line* (Plate XV.), midway between Pembroke and Weymouth. This line of coterminous contact, passing through London, was indicated instrumentally, and in this instance most self-evidently, by our finding equable but contrary tension-records at Weymouth and Pembroke, and a neutral or stationary barometer-reading in London, at this period. It will also be seen that the temperature fell equally at all places, and that the polar current finally prevailed alike over the whole area and so continued.

It may be assumed, indeed, that most of our abnormal storms arise from such conflicting air-strata as are here exemplified, the only difference perhaps being the marginal impact itself, which may range more or less to the north or south of *this* one. From some years' study of cyclonic storms, and their courses Europewards, I should say that the greater proportion of these circular storms traverse the Atlantic in zones parallel somewhat to the dotted line on this Map, their course, however, varying according as the sun is north or south of the equator; for their range is

more *northerly* as the sun approaches the tropic of Cancer, and more southerly as it recedes therefrom.

Names of Places				Amount of Rise, in decimals of an inch.	Amount of Fall, in decimals of an inch.	Fall of Thermometer, in degrees of Fahr.	Wind on May 16, and its Force.	Wind on May 19, and its Force.
Fall of Rain, in tenths of an inch.	Where Barometer rose.	Fall of Rain, in tenths of an inch.	Where Barometer fell.					
	Nairn	......	....	·77	...	5	W.S.W. 4	N.E. ... 3
1	Aberdeen	......	....	·70	...	6	S.S.W. 4	N.E. ... 7
	Ardrossan	......	....	·64	...	4	S.W. ... 5	S.E. ... 6
	Portrush	......	....	·67	...	1	S. 1	N.E. ... 2
	Galway	......	....	·52	...	4	W....... 2	E. 3
	Cork	......	....	·29	...	2	W....... 5	E. 5
1	Pembroke	......	....	·14	...	3	S.W. ... 3	N.N.E. 4
	Yarmouth	......	....	·12	...	7	S.W. ... 4	N.E. ... 4
	Heligoland......	......	....	·13	...	5	S.W. ... 4	N.E. ... 6
London.........Barometer stationary.								
		inch. ·8	Dover	...	·09	13	W....... 2	E.N.E. 7
		·5	Portland.........	...	·14	8	S.W. ... 4	N.E. ... 9
		·5	Penzance	...	·07	7	S.W. ... 5	E. 6
		·2	Brest	...	·35	7	S.W. ... 4	N.E. ... 6
		·7	L'Orient.........	...	·51	5	S.W. ... 4	N. 3
		2·2	Rochfort.........	...	·55	7	S.W. ... 1	E. 5

N.B. At Copenhagen the barometer rose ·17 between the 16th and 19th of May, the temperature fell 7°, and the wind veered from S.S.W. to N., but calm all the while.

XLII. *Cirri Clouds and Auroræ.* By F. Pratt, Esq.

[Abstract.]

From a perusal of Mr. Walker's paper on "Magnetic Storms and Earth-Currents," in the library of the British Meteorological Society, I find that considerable attention has been paid to auroral phenomena. A paper on an analogous subject is in the last number of the Society's 'Proceedings,' by H. W. Blake, Esq., the remarkable facts of which are confirmed by my own observations.

From about the 18th of April, 1863, I was much struck by the abundance and singular formation of cirri in an extremely clear sky, followed by some extreme storm-phenomena culminating on the 21st and 22nd. On the 23rd, about $12^h\ 45^m$ P.M., in a broken sky, I again observed a remarkable prevalence of the *cirri*. Passing up Dalston, I had a clear view of the N.E. Looking in that direction, a singular phenomenon met my view, in the shape of an immense coronal arch, which occupied nearly the whole of that quarter of the heavens. At the base, just over the tops of a range of low buildings, lay a long band of light filmy cloud. From this, as from the band of a crown, there extended upwards above a dozen radii, spreading out like a fan towards the zenith, but disappearing behind a mass of cumulus, extending from N. to E. What was most remarkable was the singular structure of the radii forming the arch, each of which was composed, not of a single cloud, but of a number of groups, of an oval form, piled horizontally upon each other up to the boundary of view. Each of these groups, again, was of equally singular formation, being composed of a number of fine, minute, horizontal lines of cirri, ranged in successive columns alongside each other, of which columns the oval figure was composed.

The day was afterwards very fine, with clear blue sky, and light white cumuli; the wind very strong and keen. As evening advanced, the lower strata of cumuli disappeared, leaving only long lines of cirrus visible in the extreme vault of the northern sky. As day closed, the scene became magnificent, the sky being a mass of rich golden hue, stretching from the west in extreme brilliancy nearly over to the opposite quarter of the heavens, the intermediate space being studded with small auroral tufts of light cloud, of thin filmy texture, and of the richest roseate tint. It was a sunset seldom seen in this country.

Whether any subsequent *aurora* appeared I do not know; but I observed none. I did not hear of its being observed by others,

the last appearance of the kind being that of the 15th, reported by Mr. Wood (of Weston-super-mare), in the 'Times.' It appears, however, to have been a period of both atmospheric and terrestrial disturbance, there being heavy showers of hail the same day at Shields. A pretty smart storm of thunder and lightning also passed over the southern part of Northumberland about $1^h 30^m$ P.M. (almost simultaneous with the above *auroral* appearance). That the earth was singularly excited at the same time will be manifest by the account of the earthquake at Rhodes. But whether there was any connexion between the two phenomena, from magnetic action, I cannot pretend to say. There is, however, a singular coincidence, at the same time, between the occurrence of the first shock and the auroral display of the 15th, as also of the corresponding storm, &c., of the 27–29th, both here and at Rhodes, France, &c.

The Earthquake at Rhodes.—"*On the* 16*th* of April a slight premonitory shock was felt by the inhabitants of Rhodes, but it was not *till the* 22*nd* that the visitation in all its terrible force broke upon the island. The morning of that day is described as calm and hazy; *but the wind rose about noon, and gradually increased towards night, when it blew a gale from the north. The temperature fell until it became bitterly cold.* A little before ½ past 10 at night a series of short undulatory movements from the north-east to the south took place, followed, after a brief interval, by a continuous shock, which quivered through the island for nearly a minute. Everywhere was heard the straining, cracking, and crashing of timbers and walls."

A correspondent of the 'Levant Herald' says:—"I happened myself to be sitting up; and the shock so shook my house that I was literally thrown from my chair. Only a few hardly perceptible shocks took place again during the night. About a thousand houses, more or less, have been injured, some 400 of which have been nearly altogether destroyed, and the remainder either partially knocked down or rent to an extent that will compel the pulling down of most of them. Inside the enclosure of the citadel about twenty have been demolished, and several others greatly damaged. Great injury has also been done to the fortifications, and the architectural relics of the knights. Of these last, the beautiful square tower of St. Michael, at the entrance to the larger harbour, has been rent from top to bottom, nearly the whole inner half of it, landwards, knocked entirely down. The old palace of the grand masters (now a prison) has been rent in several places, as

has also the lighthouse." This informant states the loss of life on the 22nd at fifty, and the maimed and wounded at more than double; but these numbers are confined to the town itself. In an account given by another resident, we read:—"Throughout the island above 240 people were killed, and a great many hurt. Twelve out of forty-four villages were utterly destroyed, and the others greatly injured."

XLIII.—*Behaviour of a new Pocket-Aneroid.*

By Charles V. Walker, Esq., F.R.S., Secretary.

The aneroid (No. *x*) is compensated; it is in size and appearance like a large watch; its diameter 2 in., its thickness ¾ in. It weighs 4 oz. It has been read side by side with a standard mercurial barometer by Negretti (No. 495), the index-error of which had been determined by comparison with the Greenwich standard.

The barometer-readings in Table I. are corrected for index-error and capillarity, and for temperature. The direct readings of the aneroid are given; and the difference is shown in the column that follows:—

Table I.

		Thermometer.	Barometer corrected.	Aneroid.	Difference.
	h. m.	°			
February 21 ...	8 30 A.M.	46	30·047	30·160	+·113
" 22 ...	10 0 A.M.	48	29·955	30·060	·105
" 22 ...	1 30 P.M.	50	29·955	30·080	·125
" 22 ...	9 0 P.M.	50	30·029	30·170	·141
" 24 ...	8 30 A.M.	49	29·996	30·120	·124
" 25 ...	8 30 A.M.	48	30·121	30·240	·119
" 27 ...	8 30 A.M.	50	30·001	30·130	·129
" 28 ...	8 30 A.M.	48	29·963	30·120	·157
March 1	10 0 A.M.	50	29·647	29·830	·183
" 3	9 0 A.M.	52	29·537	29·670	·133
" 5	8 30 A.M.	53	29·371	29·530	·159
" 8	10 0 A.M.	51	29·291	29·440	·149
" 9	10 0 P.M.	50	29·121	29·250	·129
" 10	8 30 A.M.	46	29·066	29·200	·134
" 11	9 0 A.M.	46	29·202	29·330	·128
" 12	8 30 A.M.	44	29·120	29·260	·140
" 14	8 30 A.M.	45	29·206	29·320	·114
" 15	10 0 A.M.	48	28·913	29·020	·107
" 16	8 30 A.M.	45	29·492	29·640	·148
" 17	8 30 A.M.	44	29·869	30·015	·146
" 18	8 30 A.M.	44	29·692	29·860	·168
" 19	8 30 A.M.	46	29·754	29·960	·206
" 21	8 30 A.M.	50	29·699	29·920	·221
" 22	10 0 A.M.	48	30·073	30·275	·202
" 24	8 30 A.M.	52	30·144	30·360	·216
" 25	8 45 A.M.	54	30·209	30·420	·211
" 26	8 30 A.M.	53	29·987	30·290	·303

TABLE I. (*continued*).

		Thermo-meter.	Barometer corrected.	Aneroid.	Difference.
	h. m.	°			
March 27	8 45 A.M.	50	30·098	30·330	·232
„ 28	8 30 A.M.	52	29·668	29·880	·212
April 1	8 30 A.M.	48	29·826	30·150	·324
„ 2	8 30 A.M.	48	29·770	30·010	·240
„ 3	9 45 A.M.	49	29·923	30·250	·327
„ 4	8 30 A.M.	51	29·709	30·050	·341
„ 5	10 0 A.M.	51	29·562	29·900	·338
„ 6	7 45 A.M.	51	29·343	29·700	·357
„ 7	8 45 A.M.	50	29·175	29·520	·345
„ 8	9 0 A.M.	51	29·401	29·730	·329
„ 9	8 30 A.M.	52	29·477	29·820	·343
„ 11	8 45 A.M.	56	29·404	29·820	·316
„ 12	10 15 A.M.	56	29·606	29·940	·334
„ 13	8 40 A.M.	55	29·659	29·980	·321
„ 14	8 30 A.M.	53	29·663	29·960	·297
„ 15	8 40 A.M.	51	29·696	30·030	·334
„ 16	8 30 A.M.	54	29·680	30·040	·360
„ 17	8 15 A.M.	55	29·813	30·140	·327
„ 18	8 15 A.M.	55	29·897	30·230	·333
„ 19	9 50 A.M.	55	29·871	30·200	·329
„ 20	8 30 A.M.	55	29·624	29·990	·366
May 3	10 15 A.M.	52	29·621	29·980	·359
„ 4	8 30 A.M.	56	29·531	29·880	·349
„ 11	8 30 A.M.	56	29·735	30·100	·365
„ 12	8 15 A.M.	55	29·461	29·840	·379
„ 13	8 30 A.M.	56	29·356	29·720	·364
„ 17	10 30 A.M.	57	29·508	29·890	·382
„ 26	8 30 A.M.	51	29·827	30·180	·353
„ 27	5 30 P.M.	57	29·925	30·300	·375
June 4	8 30 A.M.	63	29·664	30·080	·416
„ 5	8 30 A.M.	62	29·703	30·110	·407
„ 6	8 30 A.M.	59	29·148	29·580	·432
„ 7	9 45 A.M.	60	29·192	29·580	·388
„ 8	8 30 A.M.	59	29·206	29·610	·404
„ 10	8 30 A.M.	58	29·241	29·670	·429
„ 14	10 0 A.M.	60	29·706	30·110	·404
„ 15	8 30 A.M.	62	29·687	30·100	·413
„ 16	8 30 A.M.	60	29·665	30·090	·425

The following summary (which includes readings made up to the day of going to press) shows what may be called the "daily rate."

TABLE II.

	Days.	Increase.	Daily rate.
February 21 to March 17	24	+·113 to ·146=·033	+·0013
April 1 to June 16	76	+·324 to ·425=·101	+·0013
June 16 to July 24	38	+·425 to ·480=·055	+·0014
July 24 to September 5	43	+·480 to ·539=·059	+·0013

It must be borne in mind that aneroid No. *x* was strictly a new instrument; it was taken almost fresh from the maker's

hands; and time had not been allowed for the spiral spring and the corrugated box to adjust themselves to their work. It was immediately seen that its index-error was an increasing one; this is more common than the reverse; and on referring to Table I., it will be noticed that this gradual increase of error was often attended with irregular fluctuations.

This aneroid is one of the few that were made very soon after the idea had been realized of producing a really pocket-aneroid, and was received from the maker before time had been allowed for its character to be ascertained,—the only thing known being that its then reading differed but little from that of the standard, and that its index was without shake.

The irregularities recorded for the last fortnight in March, and which I have purposely omitted from Table II. because they were so marked (to wit, 0·0118, and for a couple of days as much as 0·03 per day), are hardly essential parts of the character of the instrument. They were transient, and seemed to indicate an effort, as it were, on the part of the metals to accommodate themselves to the new conditions under which they were placed. Space had not yet been found within the narrow limits of the watch-case aneroid for a curved spring, which is to be preferred to the spiral actually in use.

Rejecting, then, this irregular fortnight, the progressive increase in the mean daily rate for a period of nearly seven months—continuous for the last five months—is consistent to the ten-thousandth part of an inch. For a small instrument like this (one of the first of its kind, a form the character of which had not been ascertained), such a result is encouraging.

The behaviour of the instrument having now been tolerably well tested (it is a severe test to read it continually side by side with a standard instrument), I place it again in the hands of the maker, that its accumulated error may be taken off, and the index readjusted to the scale. I will then resume the comparative readings, and communicate to the Society any instructive results that may present themselves. Should any inherent defect be detected, I will try to replace No. x with an instrument the character of which may have been established before leaving the maker's hands.

ANNUAL GENERAL MEETING.

1863, June 17.

The business of the Ordinary Meeting having terminated, the Annual General Meeting was held; and the following Report of the Council on the state of the Society was read.

REPORT.

The observations from the various stations for the month of May have been nearly all received, and they are under examination as to the general correctness of readings; those for April have been examined, their means taken, and the hygrometrical results calculated; this heavy and continuous work may therefore be considered to be in as forward a state as possible. All results up to the end of last quarter have been printed by the Registrar-General and distributed as usual to Members of this Society.

The photographic registrations of the variations of the barometer and dry- and wet-bulb thermometers commenced at the Royal Observatory, Greenwich, in the year 1848, have been continued up to the present time, and are in constant operation. The mercury in the photographic barometer was boiled by Mr. Zambra in its tube in the year 1853; and the results since that time have been of a very satisfactory and consistent nature. Eye observations of barometer and dry- and wet-bulb thermometers, which were made every two hours from the year 1840 to 1848, have, since the establishment of the system of photographic registration, been made four times daily; of thermometers for maximum and minimum temperature of the air, established in 1840, for maximum and minimum temperature of evaporation, established 1851, and for maximum and minimum temperature of radiation, established 1840, are made twice daily. Eight rain-gauges placed at different heights above the soil are constantly observed, seven of them being read daily, and the eighth once a month. Of these gauges, four were established in the year 1840, one in the year 1854, and the remainder in the year 1861.

Osler's anemometer, established 1840, worked throughout the year 1862, without any loss of register even for a single hour; and Whewell's and Robinson's anemometers, respectively established in the years 1843 and 1859, were constantly in operation, excepting during the times of necessary repairs.

During the past year, one of the most important steps for the advancement of meteorology ever taken in England has been taken by Government. For some time past a correspondence has been proceeding, commenced some years since with one of your Secretaries, Mr. Glaisher, by the late Lord Herbert, Secretary of War, with the

view of establishing, wherever any part of the British army may be located, excepting in India, a system of meteorological observations and research, to be made subservient to the advancement of the science of meteorology, but more particularly leading to a knowledge of climate and its influence on the health of troops, and in fact to an increased knowledge of medical meteorology.

Your Council is happy to say that during the past year this work has been completed. The direction is placed in the hands of Dr. Gibson, C.B., the Director General of the Army Medical Department, and is being carried out by Dr. Balfour, F.R.S. All the instruments, that have been in the hands of the engineers, have been handed over to the Army Medical Department. New instruments to the value of £800 have been made by Messrs. Negretti and Zambra, every one of which has been examined and certified by Mr. Glaisher, and many of these are now on their way to their destination. It is intended that all the instruments now out shall come home for examination, repair, and determination of index-error. Forms have been prepared for recording the observations, and instructions sent out for placing the instruments, &c. Arrangements have also been made for the reduction of these observations. All these instruments will be placed under the charge of the Medical Officers; and such is the desire of the officers in charge, that every facility has been given to Mr. Glaisher to explain the use of the instruments, the putting them up, taking them down, putting them in order, &c., which he has done by lectures he has given to the medical pupils at Fort Pitt, Chatham, on more than one occasion.

No step in the general arrangements has been made without consultation with Mr. Glaisher; every confidence therefore may be placed in the arrangements; so that it is impossible to conceive a step promising more important results than this on the part of the Government: and to no better officers than those of the Medical Staff could such be entrusted.

The Royal Commission appointed last year for the purpose of considering the sanitary state of the army in India requested Mr. Glaisher to investigate the meteorology of India in relation to the health of the troops; this work has been done, and forms a great addition to the meteorology of India.

Mr. Glaisher has availed himself of all observations that he could collect, which have been taken over India for many years, combined them together, and deduced general and very valuable results from them.

The Council feel they can scarcely pass over the balloon ascents which have been made by Mr. Glaisher since the last anniversary. These ascents promise to be of the highest service to meteorology, and not of less importance to astronomy. The results indicate that the generally received opinion of a decline of temperature of 1° in 300 feet must be abandoned—that, on the contrary, a constantly increasing space is required for a decline of 1°, from leaving the

earth till, at great heights, the space passed through for a decline of 1° becomes very large.

It is worthy of remark here, that Mr. Glaisher, in his meteorology of India, finds that the decline of temperature with height is different in every month of the year, and generally different from that found by his balloon ascents. He considers the number of observations available for this investigation and their general agreement in the three Presidencies all but prove this fact; and if so, it would seem that no general law can hold good applicable to all places, and that it would seem that each locality ought to determine its own law of refrigeration.

The following extracts are taken from the Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, read at the Annual Visitation of the Royal Observatory, 1863, June 6:—

"The wires for observation of spontaneous magnetic earth-currents have been mounted, extending from the Royal Observatory along the poles of the South-Eastern Railway, one to a point in the neighbourhood of Croydon, the other to a point in the neighbourhood of Dartford. They are insulated with great care. I shall, in the course of this Report, again allude to them.

"The only published photographic curves with which I have been able to compare the Greenwich curves are those of Mr. Balfour Stewart, in his papers in the 'Philosophical Transactions,' 1861 and 1862. In the first of these are given the curves traced by the vertical-force instrument at Kew, from August 28 to September 9, 1859. During the whole of this period, the curves correspond, in every the minutest bend, as far as they can be compared; but the Kew instrument has failed to record the great and characteristic disturbances, even where they are certainly contained in the field of the paper, while the Greenwich instrument has registered the whole. It is the most magnificent perturbation on record. In Mr. Stewart's second paper are given the perturbations (of a very small class) in a part of 1860, August 11; they coincide to the minutest particular with those at Greenwich.

"The earth-current wires are furnished each with a galvanometer, for eye observations. This imperfect arrangement is only temporary: I have already instructed Mr. Simms to proceed with the construction of a self-registering apparatus, and have supplied the plans. I propose to make trial of ebonite for the material of the revolving photographic cylinders, as admitting of being turned to a more accurate form than the glass cylinders which we have hitherto employed.

"The meteorological apparatus is in an efficient state. Besides the barometer, dry and wet thermometers, pluviometer, and anemometer, which automatically register their respective phenomena, and can also be observed by eye, there are thermometers in the air and in the River Thames which record maxima and minima, and require to be read every day, and electrometers which can only be observed by eye.

"Many of the constants of adjustment of the magnetical and meteorological instruments were redetermined at the beginning of this year.

"*Magnetical and Meteorological Observations.*—The instruments mentioned in the last chapter are all fully employed in their respective functions. The magnetometers, barometers, and dry and wet thermometers are read by eye several times every day, in order to give zeros for their continuous photographic registers; the magnet-thermometers every day as often as appears necessary; maximum and minimum instruments once every day.

"The readings of barometer and thermometer, and the state of wind and weather, are observed every morning, and telegraphed to M. Leverrier, for publication in his 'Bulletin.' We are indebted to the London District Telegraph Company and the Submarine Telegraph Company for the gratuitous daily transmission of these telegrams to Paris.

"The photographic sheets for the barometer and thermometers are in the same state as those for the vertical force.

"The vane of Osler's anemometer, in the year 1862, made about +14 revolutions.

"Considerable labour has been given to a numerical discussion of the magnetic storms in all the three elements, from 1841 to 1857. Each storm-day has been treated separately. Availing myself of the printed measures of the values of ordinates of photographic curves in the published results of magnetic observations, I have applied to all a simple process, within the power of the youngest computer, but admitting of easy checks, for resolving every storm into its successive swells, and at the same time for displaying the irregularities or smaller swells riding upon these principal swells. The mass of reductions is at present waiting for my inspection; but the general character of appearance of results has suggested ideas to me which are in some measure confirmed by another reduction, which I proceed to mention.

"On 1862 December 14, a splendid aurora was seen. The Assistant (Mr. Ellis) in charge of galvanic observations immediately came to the Observatory, and carefully noted the indications of the galvanometers on the two earth-current wires. From these we were enabled, by easy reductions, to obtain the numerical values of the currents in the magnetic N. and W. directions, and to construct curves for them. The photographic sheet of records of declination and horizonal force at Greenwich, unfortunately, failed totally (from a chemical fault); but the Kew Committee, on my application, courteously allowed me the use of their photographs. They were perfectly good, with the exception of one part where the motion was very violent, a case for which the arrangements at Kew are not well adapted. There remained, however, enough to enable me to institute a comparison. And the result, supposing the sign of the interpretations of the Kew curves to be correct (which I have no reason to doubt, but upon which all will depend), is very remarkable. The action of the earth-currents upon the magnet is in the same direction in which the earth-cur-

rents flow, and not transverse to the current-direction, as is usual with galvanic currents.

"If this should be confirmed, then, viewing the rarity of disturbances in the vertical direction as produced by magnetic storms, and their great violence when they do occur in the vertical direction, I shall have no hesitation in suggesting, as a general theory of magnetic storms, that the idea of attraction is to be abandoned, and that they are to be referred to currents of a magnetic ether whose movements are closely analogous to that of air, the vertical movement of which occurs but in few places, but in these places is excessively violent. Much, however, must be done before such a theory can be established.

"At present, I have no unusual work on hand, with the exception of the 'Seven-Year Catalogue' and the discussion of magnetic storms, which have probably ceased to oppress the establishment; and I shall be anxious to avoid taking up any new work."

In the Kew Observatory a self-recording electrograph, on the principle of Prof. W. Thomson, is kept constantly at work. It indicates continuously the changes which take place in the electricity of the atmosphere; and Prof. W. Thomson states that he is proceeding to reduce the indications afforded by this instrument, with the prospect of very satisfactory results.

A barograph, similar to that used at Oxford, is also in operation.

By means of the waxed-paper process it is found practicable to obtain duplicate curves, one set of which is forwarded to Admiral FitzRoy, while the other is retained at the Observatory.

A self-recording Robinson's anemometer registers the space passed over by the wind. This instrument has been used at the Observatory for many years.

We may further mention the fact that magnetographs at Kew record continuously the changes in the magnetism of the earth, and that photographic impressions of the sun's disc are regularly taken, which are being reduced by Mr. De la Rue.

At the Radcliffe Observatory, Oxford, the usual meteorological elements have been observed by photography in the same manner as in preceding years, but with greater success. During the whole of the year this department has been under the charge of Mr. Lucas, who has devoted a considerable portion of his leisure time to the general study of photography, and to the improvement of the methods in use at the Observatory. At present, the details of the waxed-paper process in use here scarcely admit of improvement. The papers are generally clear and of a good colour, traces of the curves are distinct, and the results are easily read and reduced to the ordinary scales. The elements which are photographically registered are the height of the barometer by the barograph, the temperature of the air and of evaporation by the thermograph and hygrograph, and the velocity and direction of the wind by a large Robinson's anemometer, of which the results are self-registered by

photography. There is also a coarse straw electrometer, of which the indications are given by photography. This serves to show all cases of unusual electrical activity in the air; but a delicate and adequate electrical apparatus is still one of the wants of the Observatory. The rain is measured at the top of the tower (a height of 110 feet), as well as on the surface of the ground, and at another elevation of 24 feet.

All the results are discussed in a very elaborate manner for every year, especially those for the mean monthly diurnal inequalities of the different elements. The mean monthly directions of the wind are also deduced, by a very laborious process, from correct mechanical principles.

The results for 1861 will shortly be printed and circulated. Those for all preceding years, it is believed, have been presented to the Society.

The Meteorological Department of the Board of Trade continues to be directed with his wonted energy and activity by Admiral FitzRoy, F.R.S. The telegraph returns of the weather and the readings of instruments appear, as heretofore, in the daily papers, together with forecasts of the probable weather for the two consecutive days. The Report of the Department for 1862 has been published.

The following is a copy of correspondence between the Board of Trade and the Royal Society on the subject of meteorological observations, telegraphy, and forecasts (presented to both Houses of Parliament by command of Her Majesty) :—

The Secretary of the Board of Trade to the Secretary of the Royal Society.

Office of Committee of Privy Council for Trade,
Marine Department,
Whitehall, 27 February, 1863.

SIR,—I am directed by the Lords of the Committee of Privy Council for Trade to request that you will be so good as to submit the following observations regarding the Meteorological Department of the Board of Trade to the President and Council of the Royal Society.

The President and Council of the Royal Society doubtless remember that in the year 1853 a conference was held at Brussels on the subject of establishing a uniform and international system of meteorological observations. In consequence of the report of the conference, a vote was sanctioned by Parliament for expenses connected with the supply of instruments, and the collection and discussion of meteorological observations; and a special department of the Board of Trade was entrusted with the duty of carrying these objects into effect.

In order to guide the Board of Trade in the performance of duties so new to them, it was thought desirable to seek the advice of the Royal Society—advice which was fully and freely given in a

letter from the Royal Society to the Board of Trade, dated the 22nd of February, 1855. That letter was laid before Parliament, and was adopted by the Board of Trade as a guide for its subsequent proceedings. It is scarcely necessary to refer to the contents of the letter at length; but I may point out that the object then contemplated was to collect, collate, and digest observations of the phenomena of the atmosphere, so as to form a basis for meteorological science.

Under the zealous management of Admiral FitzRoy, the system so founded was brought into operation. The results will be found in the various reports and publications issuing from the Meteorological Department of the Board of Trade, of which copies are, no doubt, in the possession of the Royal Society.

In December 1859 the Council of the British Association for the Advancement of Science forwarded to the Board of Trade a resolution representing the probable importance of occasional telegraphic communications "between a few widely separated parts of Great Britain and Ireland, by which warning might be given of storms."

In consequence of this representation, and of communications with M. Leverrier at Paris, arrangements were, in June 1860, authorized by this Board, according to which a daily and mutual interchange of certain limited meteorological information was to be transmitted daily between London and Paris and different parts of the United Kingdom, the expense of telegrams being covered by the appropriation of £700 out of the vote taken for meteorological purposes.

The observations thus communicated appeared daily in the principal newspapers; and early in the year 1861 Admiral FitzRoy was so far satisfied with the experience he had acquired, that he despatched his first cautionary or storm-warning signal, and from that time he has continued to issue warnings of approaching storms.

In August 1861 Admiral FitzRoy endeavoured to further utilize the telegrams he received by publishing daily forecasts of the weather.

The gradual progress thus shown in the system of storm-warnings and weather-forecasts has, as was naturally to be expected, been accompanied by a gradual increase in the expenditure. A greater sum of money is now annually voted by Parliament to support the Meteorological Department than was at first taken, and a large proportion of the money so voted is now applied to purposes not at first contemplated, *i. e.* to telegraphy, storm-warnings, and daily forecasts.

The Board of Trade are impressed with the importance of this change, and with the responsibility which will rest with them, should they, without further advice, determine to ask for a progressive increase in the meteorological vote, and to divert it from the purposes at first contemplated to a system of foretelling weather. They are reluctant in any way to impede the progress of a system which may prove to be of practical value in saving life

and property; but, at the same time, they wish to be satisfied that the knowledge of the causes and preceding indications of the phenomena of the atmosphere has arrived at such a perfection as to render advisable a continued and increased expenditure on weather-forecasts, for the guidance of the masters of merchant vessels and others carrying on maritime pursuits on the coasts of the United Kingdom.

The President and Council of the Royal Society, in their letter of the 22nd of February, 1855, whilst favouring my Lords with their views of the principal objects to be then sought for in the interest of meteorological science, added that they would at all times be ready to resume the consideration, if required, and to supply any further suggestions which might appear likely to be useful.

My Lords feel, therefore, that they are not too far trespassing upon the attention of the President and Council by again consulting them concerning the operations of the Meteorological Department of this office, and especially concerning the new features which those operations have assumed.

The questions upon which my Lords are particularly anxious for information are—

1. Whether the science of meteorology is now in such a state as to admit of a permanent reliable system of storm-signals and daily weather-forecasts; and

2. Whether the progress and useful application of meteorological science will be more efficiently promoted by devoting the money voted by Parliament to the original objects contemplated, viz. the collection, tabulation, and discussion of meteorological phenomena, or by devoting it to the system of telegraphy and weather-forecasts.

I am to add that Admiral FitzRoy is ready to give full information upon the subject to the President and Council, and he will gladly furnish them with such of his printed Reports as they may desire to see.

I have the honour, &c.
(Signed) T. H. Farrer.

To the Secretary of the Royal Society.

The Secretary of the Royal Society to the Secretary of the Board of Trade.

The Royal Society, Burlington House,
27 March, 1863.

Sir,—I am directed to acknowledge the receipt of your letter of the 27th of February, 1863 (No. 1408), submitting, by direction of the Lords of the Committee of the Privy Council for Trade, certain questions concerning the Meteorological Department of the Board of Trade, on which it is desired to obtain the opinion of the President and Council of the Royal Society.

Before proceeding to reply to these questions, I am desired to assure my Lords that they have rightly judged of the disposition

of the President and Council of the Royal Society at all times most readily to render any service in their power to any Department of Her Majesty's Government.

In accordance with the suggestion contained in the letter from the Board of Trade, the President and Council placed themselves in communication with Admiral FitzRoy, and have been gratified by finding the utmost desire on the part of that officer to afford them the fullest information.

They have been glad to learn from Admiral FitzRoy, in the first instance, that the original objects for which the Meteorological Department was formed are still kept steadily in view, and that their interest and importance are by no means lost sight of in consequence of the other public duties which have been since superadded.

In originating the proceedings required by such an extensive and responsible inquiry as that of a system for anticipating the approach of storms, and telegraphing these anticipations to the seaports on our coasts, a portion of the time and thoughts of the Superintendent, which would otherwise have been given to the subjects which previously occupied him, must necessarily have been diverted therefrom; but the President and Council are glad to learn from Admiral FitzRoy that the system is now so established in his office as (excepting for the purposes of its further extension and improvement) to set free his own attention for the coordination of the materials which he has already accumulated, bearing generally on the meteorology of the globe, and specially on that branch of it which has been appropriately denominated "Ocean Statistics."

With respect to the public importance and the practical success of the superadded branch of the duties of the Meteorological Office, the Board of Trade have opportunities of judging which the Royal Society have not; but the President and Council have noticed with great pleasure, in the replies to inquiries circulated by the Board of Trade to the various ports of the Kingdom, that three only of the replies are unfavourable, whilst those that are decidedly favourable amount to no less than forty-six.

In the forewarnings of storms much must as yet undoubtedly be viewed as in a great measure tentative; but there is one class of cases on which such premonitory information is entitled to be regarded as resting on more assured scientific relations. Admiral FitzRoy considers that he has satisfactorily established the occasional occurrence of storms of a cyclonic character, of very limited diameter, not much exceeding perhaps that of the British Islands themselves, and originating in their vicinity. The practice of forewarning is specially suited to such storms. They are characterized by great violence, and by frequent and rapid changes in the direction of the wind. The key to their comprehension is supplied by the telegraphic reports which convey to the central office a knowledge of the various simultaneous directions of the wind in different localities; and when once comprehended, they are particularly suited for forewarning, inasmuch as, in its general course,

the advance of the cyclone is steady in direction and moderate in rate.

In connexion with this subject the President and Council revert with satisfaction to a reply by Sir John Herschel to the Royal Commission on Lights, Buoys, and Beacons, that "the most important meteorological information which could be telegraphed would be information first received by telegraph of a cyclone actually in progress at a great distance, and working its way towards the locality. There is no doubt that the progress of a cyclone may be telegraphed, and might secure many a ship from danger by forewarning." It is obvious that this remark, which refers to the approach of a distant cyclone, is equally applicable to cyclones originating in or near our islands, the existence of which has been made known by the system of telegraphy which Admiral FitzRoy has established.

With respect to the "forecasts of the state of the weather" which are published in the newspapers, the President and Council learn from Admiral FitzRoy that they really occasion no cost to Government, and scarcely fall, therefore, within the questions submitted for reply; moreover, the President and Council have no data whereon to rest a conclusion in regard to the degree of reliance to which these last-named forecasts may be entitled.

I have, &c.,

(Signed) W. SHARPEY, M.D.,
Secretary of the Royal Society.

To the Secretary,
&c. &c. &c.
Board of Trade.

M. Leverrier, Director of the Observatory, has addressed to his Excellency le Ministre d'État the following Report on the meteorological theory of M. Mathieu (de la Drôme) *, which is extracted and translated from the daily Meteorological Bulletins, of the dates of April 7, 8, 9, and 11, 1863:—

M. le MINISTRE,—You have done me the honour of communicating to me a request addressed to the Emperor by M. Mathieu (de la Drôme), and to require my opinion on the subject of the theories of my old associate in the Legislative Assembly.

Already M. Mathieu had gained the attention of the Academy to these same questions by various letters, and that of the public by means of the newspapers. He had also addressed to His Excellency the Ministre d'Instruction Publique et des Cultes a detailed letter, which he has reproduced at the commencement of a pamphlet wherein he sets forth some of his fundamental rules.

These communications did not meet with a favourable reception from the Académie des Sciences; and the report of the Section des Sciences du Comité des Sociétés savantes, to which the Minister referred the letter that had been addressed to him, is far from concurring in the soundness of the theory of M. Mathieu.

However, since the author has appealed to the Emperor, I thought I should be acting in conformity with the wishes of His

* *Vide* Proc. Meteor. Soc. No. 5, p. 266.

Majesty by studying M. Mathieu's theory, as he has laid it down in his pamphlet, sufficiently to give an opinion as to its value. Following M. Mathieu over his own ground, that of figures, I shall perhaps not arrive at the same conclusions as he has done. However, he will have no reason to complain that he has been condemned without a sufficiently serious examination.

M. Mathieu bases his researches on the quantity of rain upon the meteorological observations commenced at Geneva on Jan. 1, 1796, by M. De Saussure, and continued without interruption from that time. He takes account of the quantity of water fallen and collected each day; he groups the results according to the phases of the moon, and the hour at which it entered into this phase; and discussing what he calls *the horary influence of the moon upon a phase taken isolately*, he finishes by setting forth this first rule:—

"SEPTEMBER, OCTOBER, NOVEMBER, and DECEMBER.—The new moon that occurs between 8 and 9 A.M. presents more water than that which occurs between 7 and 8 A.M.

"The first case occurred........................	17 times.	
The second „	15 „	
The seventeen former cases presented ...	532^{mm} of water.	
The fifteen latter „ „ ...	266 „	
Mean of the former cases....................	$31\frac{5}{17}$ „	
„ „ latter „	$17\frac{11}{15}$ „	"

Let us dwell upon this first rule. Doubtless the author will have placed at the head of his precepts the one that he would consider as the best-established; and it is right that we should begin where he has himself begun.

M. Mathieu does not give the different quantities of rain, of which he offers only the sum. This could not satisfy us. We conceive that the author had desired to be brief; but he should at least have given a complete illustration of his mode of discussion. In statistical researches, illusion is easy; it requires a great amount of skill to avoid the errors that too frequently arise from an artificial grouping of the figures.

In order to fill up this blank, I have had recourse to the publications of the Observatory of Geneva, and have extracted the figures upon which M. Mathieu has laid his foundation.

There will be found in the following Table the indication of the quantity of rain fallen in the first phase of the moon, when the moon becomes new in the months of September, October, November, and December, and at the hours indicated by M. Mathieu, namely, from 7 to 9.30 A.M. I have even extended this Table to the new moons that have occurred between 6 and 7 A.M., and between 9.30 A.M. and noon, that which takes place before and after the selected hours appearing to me to be of a nature to throw light upon the question.

Following the plan laid down by the author, I have had regard to the day on which the new moon occurred, and neglected that on which the first quarter occurred. I am not aware whether he

took a precaution that I have taken. I reduced all the quantities of rain to a like duration of seven days. When the duration of the phase was only six days, I have added a sixth to the quantity of water measured; when the phase was of eight days, I have abstracted from it an eighth. However, this correction has no influence over the general results.

Finally, I retain, as M. Mathieu has done, Paris time, which is perfectly legitimate.

Year.	Day and Hour of the New Moon.		Rain during the first phase.	Mean.	Year.	Day and Hour of the New Moon.		Rain during the first phase.	Mean.
		h m	millims.				h m	millims.	
1841.	15 September ...	6 11	12·4	22 millims.	1830.	15 December ...	8 29	4·5	21 millims.
1800.	16 December ...	14	0·5		1834.	8 November ...	33	0·0	
1853.	30 ,, ...	15	3·4		1831.	6 September ...	42	31·7	
1851.	25 September ...	21	49·1		1828.	9 ,, ...	43	61·0	
1812.	4 November ...	23	20·1		1853.	1 November ...	48	7·0	
1842.	4 October	33	14·1		1823.	4 October	51	4·2	
1798.	10 September ...	41	60·2		1856.	27 December ...	54	7·0	
1797.	18 December ...	48	8·7		1840.	25 October	9 7	107·2	
1810.	28 October	7 7	25·2		1847.	9 ,, ...	16	3·7	
1807.	2 September ...	14	25·2		1800.	18 ,, ...	21	8·9	
1821.	26 ,, ...	16	10·6	21 millims.	1832.	22 November ...	26	5·4	
1833.	13 October	16	75·0		1801.	6 ,, ...	33	4·6	
1832.	24 September ...	17	0·0		1815.	1 ,, ...	42	0·0	
1810.	26 December ...	18	36·2		1848.	27 September ...	45	10·2	
1834.	30 ,, ...	19	0·0		1844.	10 November ...	46	13·0	22 millims.
1833.	11 ,, ...	21	23·4		1854.	20 ,, ...	10 11	38·2	
1820.	7 September ...	22	0·0		1858.	5 December ...	19	3·9	
1852.	13 October	24	0·0		1855.	9 ,, ...	27	5·5	
1808.	20 September ...	36	25·2	22 millims.	1835.	20 November ...	39	0·0	
1843.	23 October	45	17·5		1824.	20 December ...	54	29·1	
1846.	20 ,, ...	53	20·8		1814.	13 October	57	14·2	
1831.	4 December ...	57	20·0		1804.	2 November ...	59	24·3	
1802.	25 November ...	8 4	49·0		1855.	11 September ...	11 1	21·6	
1838.	17 ,, ...	11	33·7		1845.	1 October	8	49·5	
1854.	22 September ...	12	0·0	21 millims.	1857.	16 December ...	11	13·8	
1824.	22 October	13	18·6		1803.	14 November ...	34	29·5	
1799.	29 September ...	13	70·7		1837.	29 October	42	40·3	
1839.	6 November ...	21	19·2						

It will be seen that, when the new moon occurs from 6 to 7 A.M., or from 9.30 to 11.30 A.M. the rain is at a mean of from 21 to 22 millims.

From 21 to 22 millims. are also collected when the moon occurs between 7 and 8 A.M.

Finally, when the new moon occurs from 8 to 9.30 A.M., the mean quantity is still the same.

We may therefore conclude that the assumed rule, given by M. Mathieu for Geneva, has no foundation.

Now that we have all the figures before the eye, the fact which caused M. Mathieu's illusion is palpable. It is the great quantity

of rain (107 millims.), which fell at Geneva in 1840, during the first phase of the moon, which commenced on October 25 at 9.5 A.M. [qy. 9.7 ?] Suppress this year (1840), and nothing of the law remains. At this point, which for the fifteen other years, in which the moon occurred from 8.11 to 9.26 A.M., which is, according to M. Mathieu, the great period of rain, the mean amount, on the contrary, is not more than 18¼ millims., which is the smallest of all.

This answer, extracted from the figures, may yet assume another form, under which it will strike every one. The mean quantity of rain in the lunar conditions under consideration, as may be seen, is 22 millims. Very well: in the seventeen years for which the new moon occurs between 8 and 9.30 A.M., and which according to M. Mathieu should be very rainy, *there are eleven* in which the rain is below the mean, and only six in which it is superior to this mean. Where then, we ask, is the law which is false more than half the time? I even think that, had M. Mathieu first considered the question under this point of view, he would have deduced a result diametrically contrary to the rule that he had given.

Besides it is perfectly well known that, when we desire to establish physical laws, we must carefully guard ourselves against every combination of figures in which the result is exceptionally influenced by a solitary fact, as takes place in the case before us.

The first rule given by M. Mathieu being demonstrated false, we do not think it necessary to enter here into a detailed examination of the other laws of the author, and we confine ourselves to stating that they are still further without foundation, and that M. Mathieu has taken for rules that which is merely the expression of the extreme variability of the phenomena of rain.

Mr. G. J. Symons has so recently described (Proceedings No. 6) the progress he has made in collecting statistics of the fall of rain in the British Isles, and other matters connected therewith, that it is unnecessary to refer here at any length to the subject. It ought, however, to be mentioned that a Member of this Society has recently undertaken to conduct at his sole cost an elaborate series of experiments, having for their object the accurate determination of the variations in the fall of rain indicated by gauges of various diameters in close juxtaposition and at a uniform height above the ground, of the variation in the amount collected in gauges of uniform diameter but at different elevations above the ground, and the laws to which this variation is subject. Such an expenditure of time and money merits the warm approval of this Society. Mr. Symons intends in a few days to examine the locality in which it is proposed to erect these instruments; and should it be found suitable, their construction will be proceeded with immediately.

Among the questions which have had the attention of your Council has been the formulæ for and preparation of ozone-paper. Specimens of various papers, all prepared by the same formula,

were in no way uniform in the tints they acquired under similar conditions of exposure. A Committee was nominated to discuss this question; but subsequently Mr. Lowe had met with great success in preparing reliable ozone-paper, and little was left for the Committee to do.

The continued accession of new Members having exhausted the copies which remained of the last impression of the 'Institutes' of this Society, the opinion of the Council has been taken as to what corrections or alterations, if any, should be recommended to be made, before printing off a further supply. The substance of the emendations, which will be recommended in the form of resolutions at this Annual General Meeting, may be summed up in a few words.

The letter referred to in Rule 11, advising an Ordinary Member of his election, to be a printed form, and to be given in the "Appendix" to the Institutes as "Form No. 4."

It is proposed that Rule 16 shall be modified to meet the case of Members elected on and after the Annual General Meeting, and relieve them of the whole or part of the annual contribution for the portion that remains of the current year of their election.

The diploma referred to in Rule 24, advising an Honorary Member of his election, to be a printed form, and to be given in the "Appendix" to the Institutes as "Form No. 5."

The Council consider that it would be advantageous that the Society should hold more than *four*, the present number of Ordinary Meetings, in each Session; and they would propose that the number should be increased to *six*, inclusive of the Annual General Meeting in June. They have therefore suggested that Rule 34 be revised to meet this, and that the months in which the meetings are held should be January, February, March, April, June, and November.

There are some verbal alterations recommended in Rules 35, 39, and 41, as to the hour of meeting, the day and hour of the Annual Meeting, and the duration of the ballot, which Members may be disposed to have less rigidly fixed than they now are.

In consequence of a letter addressed to the Royal Geographical Society, and subsequently passed over to this Society, as being more qualified to deal with the question, from Lieut.-Col. Cameron, H. B. M. Consul in Abyssinia, expressing a desire to be of service to the science of meteorology, and to make observations under proper guidance, your Council appointed a Committee, consisting of Mr. Glaisher, Mr. Galton, and Dr. Thomson, to consider what action could be taken in respect to the suggestion contained in that letter.

The opinions of the Committee were embodied in a draft of a Report, of which copies were sent to each Member of Council for his opinion and suggestions. Subsequently Mr. Galton, the reporter, having collected the various memoranda that reached him,

submitted the following Report, which has been adopted by the Council. It bears not simply upon the case alone that was before the Council, but has regard to the more general case of residents abroad who feel the importance of collecting observations, and desire themselves to become observers. There are many who, in the absence of simple and correct instructions, hesitate to make observations, in the fear of collecting materials that may possibly, through their inexperience, have no scientific value, and be worse than useless.

The Committee purposely left out the barometer, as at once involving and implying a higher class of observations than this particular organization is intended to meet. The barometer is also a very difficult instrument to transport. How far aneroid observations might hereafter be adopted may possibly become a subject for future consideration.

Meteorological Instructions for the use of inexperienced Observers resident abroad.

The Council of the Meteorological Society invite the cooperation of those who may be willing and qualified to furnish the meteorological elements of places, in the neighbourhood of which no adequate observations have hitherto been made.

They are prepared to publish tabular statements of the accompanying form, on receiving not only the necessary materials in a

Place.				
Lat.		Long.		Elev^{n}
	Mean temp.	Monthly range.	Rain, &c.	Period. winds.
Jan.				
Feb.				
Mar.				
April				
May				
June				
July				
Aug.				
Sept.				
Oct.				
Nov.				
Dec.				
Year				
No. of years' observation............				
Hours and mode of observation...				

shape ready for publication, but also copies of the limited observations hereafter alluded to, and of subsequent calculations. These are intended to be retained in the Library of the Society, and are required as permanent records, to give evidence of the sufficiency

of the data whence the printed results have been obtained, and to afford opportunity of investigating such anomalies as may at any future time call for inquiry.

The following instructions have been framed to facilitate the labours of those who have little leisure and experience in conducting meteorological observations, and show the minimum of effort with which trustworthy results can be obtained.

In the desire of lightening the expenses of their accepted contributors and of ensuring the trustworthiness of the instruments they employ, the Council of the Society will be happy to forward, through one of their Secretaries, a simple outfit of the necessary thermometers and rain-gauges, verified and packed in readiness for immediate shipment and use, on receiving a prepayment of £2 10s. to meet their cost. The cost is liable to vary within small limits, according to the varying charges of the makers and the introduction of new classes of instruments, but it will in no case exceed the above-mentioned; sum and the surplus, whatever it may be, will be returned. The instruments included in the outfit are 1 maximum and 1 minimum thermometer; 1 ordinary thermometer, with a range adapted to the proposed station; 1 rain-gauge. The case or cases that contain them will be about 10 inches long, and 4 to 5 inches wide and deep. Their weight will be about 2 lbs., and they will travel securely as an ordinary package.

Geographical Position.

Latitude, Longitude, and Elevation above the sea-level.—The authorities whence these have been taken, or the method by which the observer has determined them for himself, must be stated.

Observations on Heat.

1. *To Expose Thermometers.*—The instruments must be placed in a carefully selected position, or all their results will be vitiated. Choose an airy place, where there is continuous, dense, and ample shade. There set up a box of not less than 2 feet in height, width, and depth. It must be constructed precisely on the principle of an ordinary meat-safe; that is to say, it must be roofed (and better still, double roofed) from the rain, and have perforated sides, whether of gauze, trellis-work, or Venetian blinds, through which the air may pass with perfect freedom. It must be fixed on a stand or be suspended 4 feet above the ground. The thermometers should be hung on supports placed in the middle of the box, except where otherwise mentioned in the 1st method, § 3.

2. *Monthly Mean Temperatures.*—The average of the daily means, taken by one of the methods described in the next paragraph during an entire month, gives the monthly mean. If occasionally a day or a month be dropped, a gap must be left in the record and no attempt be made to fill it.

3. *Daily Mean Temperatures.*

1st Method: This is the more accurate, but requires observations to be made *twice* in each day.

Procure a jar or box, of not less than 8 inches in length, width, and depth; fill it with dry sand, and set it in a properly exposed box (§ 1). Place a thermometer upright in the middle of the sand, with its bulb buried from 3 to 4 inches below its surface. Note its readings twice a day, at intervals of twelve hours, say at 9 A.M. and 9 P.M.; the mean of these readings may be accepted as the daily mean.

2nd Method: By observations made *once* in each day.

Hang a maximum and a minimum thermometer on supports, as described in § 1, and note their readings once daily, either in the morning or in the afternoon, and readjust the indexes. The mean of the maximum and minimum usually differs from the mean temperature of the day by less than half a degree; but occasionally (as at Barnaul in Central Asia) the difference exceeds $1\frac{1}{2}°$. The liability to a constant error of this amount is too serious to be passed over without investigation, especially as the approximate correction due to each month can be readily ascertained by making occasional use of the 1st method as a standard of comparison. When the year's work is completed, it will be easy to estimate the corrections due to the several months, and to apply them to the monthly means obtained by this 2nd method.

4. *Monthly Range* is the difference between the lowest and highest readings during the month.

5. *Yearly Means*, whether of *temperature* or of *range*, are the averages of the monthly means.

"The enclosure of a maximum and minimum self-registering thermometer in a large cask of dry sand, which might be opened and read off twice a year, would also probably afford a very accurate mean result."—*Sir John Herschel.*

Rain, Snow, and Dew.

6. These must be measured by a gauge, which should be placed on the ground or on a low stand in an exposed situation. The relation of the units of length and weight is such that the tenth of an inch of rain falling into a vessel whose mouth is a circular area of about two inches and nine-tenths in diameter (1·4467 inch radius) will weigh an ounce (Troy). Every medicine-chest contains a fluid-ounce (Troy) measure; and, failing this, it will suffice to mark the space occupied in a small vessel by 480 drops of water, whose weight is one fluid-ounce. A properly made rain-gauge and graduated measure is, however, preferable to any makeshift.

Wind.

7. Practised observers rarely use a weathercock, but watch the way the clouds (when any) are drifting. These are far steadier in their course than anything driven by the surface currents of wind. For

the requirement of the tabular statement now desired, it will be sufficient to note the prevalence of periodical weather.

The Meridian, or True North and South Line, is obtainable as follows:—Set a straight stick or pole upright in a plot of level ground, by the help of a plummet. Loop a string to it, and, with the base of the pole as a centre and the string as a radius, scratch a circle on the ground of such a size that the shadow of the pole shall fall somewhat within it at noon. Keep a sufficient watch on the shadow of the pole to ensure your being present when its top enters the circle in the forenoon and leaves it in the afternoon. Mark the places where it cuts it. Lastly, bisect the interval between the two marks, and drive in a peg to note the place permanently. The pole and the peg will be in the same Meridian Line. It is best to draw three or four concentric circles, and to drive the peg in the line that corresponds most closely with the mean of the several independent determinations.

If the compass be used, allowance must of course be made for the variation of the needle.

FOOT-NOTES.

The *No. of years' observations* would be printed thus:—
3 years; viz. 1860, 1861, and 1862–3.

The *Hours and mode of observation* would be printed thus:—
9 A.M. and 9 P.M., or max. and min. read in forenoon (as the case might be).

The description should be recorded more in detail in the MSS., where the spelling should be unabbreviated.

In the Report which was read at the last Annual Meeting, the Council informed Members that one of the Secretaries had volunteered to conduct, for a time, the 'Proceedings,' as far as editorial work was concerned, and until the publication was tolerably well established. With the business of this day, material for the last Number of the First Volume is provided.

Mr. Walker has found that the business and correspondence connected with the publication of the consecutive Numbers increases, and occupies an undue share of the little time at his disposal after his active official duties are over. He does not withdraw from his charge, nor does he undertake to prolong it indefinitely; but he feels that the work will be much more efficiently done when it is in the hands of an editor who is able to devote more time to it than he can possibly expect to do.

The Council would therefore call the attention of Members to the probability of the business connected with editing the 'Proceedings' forming at no distant day one of the charges against the revenue of the Society, which, however, there will be no difficulty in meeting, if the numerical strength of the Society continues to increase as it has done during the last two years.

The number of Annual Subscribers on the Register of the Society at the present time is 240; add to this, there is £450 of

stock in the New Three per Cents., standing in the name of the Society. With a few exceptions, the accession of new Members is for the most part due to the exertions of a few active Members of the Council. It is to be desired that the Members generally should in like manner exert themselves; for in proportion as the numerical strength and consequent revenue of the Society increase, so will its usefulness and its power of promoting the interests of meteorology.

The following Table will show the present numerical strength of the Society, and the changes that have occurred since the last Annual General Meeting:—

	Members.			Totals.
	Life.	Ordinary.	Honorary.	
1862, June 18	27	203	11	241
Since Elected............	2	46		48
Since Compounded ...	3	−3		0
Deceased	...	−2	−1	−3
Retired	...	−4		−4
1863, June 17	32	240	10	282

The total number of Members elected this Session has been 48, from which are to be deducted 7, namely, 4 retired and 3 deceased, which makes the effective addition of number 41.

The Society have to regret the loss, by death, of Mr. W. Kell, of Gateshead, who was elected on January 18, 1860; and of Mr. R. C. Despard, of Kensington, who had joined the Society so recently as March 19, 1862, and whose death was very sudden (a severe attack of inflammation of the lungs terminated fatally after only a few days' illness); also of M. Bravais, the celebrated French meteorologist, and one of our Honorary Members.

Seven numbers, in all, of the 'Proceedings' have been printed, 500 copies of each number having been struck off. The printing-costs will be found in the Treasurer's accounts for the last and for the present session. The nine Plates (in No. 5) which illustrate Mr. Glaisher's paper on Balloon Ascents have been liberally presented to the Society by one of the Members.

The total number of copies of the 'Proceedings' purchased by the public to May 22, 1863, has been—

No. 1......63	No. 3 24	No. 5......13	No. 7...... 2
No. 2......32	No. 4......21	No. 6...... 7	

The stock on hand at the same date, were:—

Ordinary Meeting.			On hand.		
1861, Nov. 20.	No. 1	Proceedings	43.	Published	1862, Feb. 10
1862, Jan. 15.	„ 2	„	105.	„	„ Apr. 10
„ Mar. 19.	„ 3	„	125.	„	„ June 7
„ June 18.	„ 4	„	129.	„	„ Sept. 23
„ Nov. 19.	„ 5	„	157.	„	1863, Apr. 7
1863, Jan. 21.	„ 6	„	164.	„	„ „ 21
„ Mar. 18.	„ 7	„	175.	„	„ May 20
		Total in hand......	898		

The Eighth Number of the 'Proceedings,' which will complete the first volume, will be placed in the printers' hands immediately after this Meeting, and will be pressed on, so that it may be in the hands of Members without delay.

The following is a List of the Papers read at the Ordinary Meetings of the Society, during the Session 1862–63. They are 21 in number.

1862, November 19.

1. "On the Meteorological Observations made in Eight Balloon Ascents." By Jas. Glaisher, F.R.S., Secretary.
2. "Climate of Belize, British Honduras." By the Hon. S. Cockburn.
3. "Sundry Meteors."
4. "Great Meteor of 1862, Sept. 19."

1863, January 21.

5. "Average Height of the Barometer in London for 83 Years." By H. S. Eaton, Librarian.
6. "On the Rain-fall of the British Islands during the years 1860, 1861, 1862." By. G. J. Symons.
7. "On the Mean Annual Temperature of Western Europe, compared with other Climes." By Richard Adie.
8. "On the Effect of Light upon Ozone Paper." By John Atkinson.

1863, March 18.

9. "On the Winter which occurs in the Spring of the Year; and the Summer which occurs in the Fall of the Year." By John C. Bloxam.
10. "Meteorological Report of Hurricane at Seychelles, on 11th and 12th October, 1862." By R. P. Brunton.
11. "Cirri Clouds and Aurora." By H. W. Blake.
12. "Climate of Belize, British Honduras." By the Hon. S. Cockburn.
13. "Description of Baudin's Minimum Thermometer." By H. A. Negretti.

1863, June 17.

14. "On the Theory of Vapour-pressure." By John Charlton Bloxam.
15. "Note on the Theory of Vapour-pressure." By G. B. Airy, Esq., F.R.S.
16. "On the Hurricane of May 1862, at Highfield House and Newark." By E. J. Lowe.
17. "Aurora Borealis seen on March 21, 1863." By E. J. Lowe.
18. "Notes on the Climate of Belize." By the Hon. S. Cockburn.
19. "The Antagonism of the Polar and Equatorial Air-Currents, &c." By Col. Austen.
20. "Cirri Clouds and Auroræ." By F. Pratt.
21. "Behaviour of a New Small Aneroid." By C. V. Walker, F.R.S., Secretary.

Mr. Glaisher's paper, "On the Meteorology of England for the years 1855 to 1862," was in part communicated to this Meeting, and is reserved for a future date.

The following is a List of the public institutions and individual meteorologists, at home and abroad, to whom the publications of this Society are presented by order of the Council:—

1. The Royal Society.
2. The Royal Observatory, Greenwich.
3. The Royal Society of Edinburgh.
4. The Royal Irish Academy.
5. The Royal Astronomical Society.
6. The Royal Institution.
7. The Radcliff Observatory, Oxford.
8. The Meteorological Department, Board of Trade.
9. The Institution of Civil Engineers.
10. The Scottish Meteorological Society.
11. The Liverpool Literary and Philosophical Society.
12. The Manchester Literary and Philosophical Society.

13. Athens—The Director of the Royal Observatory.
14. Hobart Town, Tasmania—The Director of the Observatory.
15. Lisbon—The Academy of Sciences.
16. Madrid—The Academy of Sciences.
17. The American Philosophical Society.
18. Toronto, Canada—The Directory of the Observatory.
19. Christiania—The Royal University.

20. Ballot, Dr. Buys,—Meteorological Institute, Utrecht, Holland.
21. Bienconi, Dr.,—Bologna, Italy.
22. Bogoslowski, Prof.,—Breslau.
23. Bohmen, Dr.,—Prague.
24. Capelli, Sig. G.,—Brera Observatory, Milan.
25. Edlund, Edward,—Stockholm.

26. Everett, J.,—King's College, Windsor, Nova Scotia.
27. Fournet, M. J.,—Hydrometric Commission of Lyons, France.
28. Frenreiss, Dr.,—Buda, Hungary.
29. Fritsch, Karl,—Vienna.
30. Hansteen, Dr.,—Christiania, Sweden.
31. Hardinger, Dr.,—Vienna.
32. Heïss, Dr.,—Münster.
33. Henry, Prof. Joseph,—Smithsonian Institution, Washington (6 copies).
34. Kämtz, Prof. L.,—Dorpat.
35. Kuppfer, Prof. A. T.,—St. Petersburg.
36. Lamont, Prof.,—Munich.
37. Leverrier, M.,—Imperial Observatory, Paris.
38. Lindhagen, Dr.,—Academy of Sciences, Stockholm.
39. Mann, Dr.,—Pieter Marity Berg, Natal.
40. Perrey, Dr. Alexis,—Dijon, France.
41. Plantamour, Dr.,—Geographical Society, Geneva.
42. Poëy, M. A.,—Havanna, Cuba.
43. Pogson, Norman,—Royal Observatory, Madras.
44. Quételet, Prof.,—Royal Observatory, Brussels.
45. Secchi, Father,—Collegio Romano, Rome.
46. Silva, Senh. J. A. Da,—Marine Observatory, Lisbon.
47. Sinobas, Don Manuel Rico y, — Royal Observatory, Madrid.
48. Twining, Prof.,—Yale College, Connecticut.

Your Librarian has much pleasure in congratulating the Society on the greatly improved condition of the Library.

With few exceptions, all the books are now bound; while the frequent application by Members for the loan of meteorological works proves the high value set upon them.

The distribution of the 'Proceedings' of your Society abroad has resulted in a corresponding increase in the number of works received from Foreign Societies and Institutions, many of them are of great value; and others have been promised.

The want of space referred to in the last Report demands immediate consideration, as the evil becomes more pressing day by day. The books are now placed on the selves one behind the other, two or three deep, so that quite one-half of them are out of sight.

Since the Catalogue of the Society was printed, in August 1862, the following additions have been made to the Society's Library by presents from their respective authors and Institutions, to whom the thanks of the Society have been awarded:—

SUPPLEMENTARY CATALOGUE, OF BOOKS

ADDED TO THE

LIBRARY OF THE SOCIETY.

AUGUST 1862 TO JUNE 1863.

A.

American Philosophical Society (held at Philadelphia). Transactions, vol. xii.; New Series, parts 1 and 2, 1862; Proceedings 1861.

Annuaire Météorologique de la France. 1849.

B.

Bangalore, Meteorological Observations at, in 1861.

Board of Trade. 1862, Report. 1863.

British Columbia. Meteorological Observations taken at New Westminster. 1862.

C.

Casella, L. P. Catalogue of Scientific Instruments.

Christiania. Meteorologische Beobachtungen.

Clifton, The Meteorology of. By W. C. Burder, F.R.A.S. 1863.

Climate of Great Britain. By John Williams. 1806.

D.

Dijon. Observations Météorologiques. Par Alexis Perrey, 1859–1862.

Dove, The Law of Storms. Translated by R. H. Scott, M.A. 1862.

F.

FitzRoy, Admiral Robert, F.R.S. The Weather-Book. 1863.

Fournet, J. Sur les Relations des Orages avec les points culminants des Montagnes, etc. 1862. Lyons.

G.

Graham, Col. J. D., U.S. Improvement of Harbours and Piers, 1855–56.

——. On the Improvement of the Harbours of Lakes Michigan, St. Clair, Erie, Ontario, and Champlain for the year 1860.

I.

India, Report on the Meteorology of. By Jas. Glaisher. 1863.

L.

Leverrier's Bulletins. March 1863.

Lisbon. Memorias da Academia Real das Sciencias. 8 vols. 1854, &c.

M.

Madrid. Annuario del Real Observatorio. 1863.
Mauritius. Proceedings and Transactions of the Meteorological Society. 1861, 1862.
Menell, H. T. Meteorological Report for 1861.
Météorologie Simplifiée, par Pierre Béron. 1863.
Meteorologische Waarnenimingen in Nederland. 1861.
Mississippi River, Report on. By Capt. A. A. Humphreys and Lieut. Abbot. 1861.

P.

Phillips, R. On Atmospheric Electricity. 1863.

Q.

Quételet. Sur le Climat de la Belgique. Tome Second. 1857.
——. Sur la Physique du Globe. 1861.

R.

Royal Institution, Proceedings of the. 1851–1863.
Russia. Correspondence Météorologique. Par A. J. Kupffer. 1853, 1855, 1857, 1858, 1859, 1860.

S.

Smithsonian Institution. Results of Meteorological Observations made under the Direction of the United States Patent Office and the Smithsonian Institution, from the year 1854 to 1859 inclusive. Report 1860.
——, Catalogue of Publications of. Corrected to June 1862.

T.

Tasmania. Meteorological Tables. By Francis Abbott. 1856; 1860–1862.

V.

Van Diemen's Land. Meteorological Tables. 1841–54.

In addition to these contributions to the Library, the Society have to acknowledge, with thanks, a present which they have received from the Government of Natal, at the hands of Dr. Mann, of the Meteorological Diagrams that were exhibited by that Colony at the International Exhibition, 1862.

The Council take also this opportunity of placing on record that, shortly after the decease of our then President, Robert Stephenson, Esq., F.R.S., his executors presented the Society with an engraved portrait of that gentleman.

The Society continue to be indebted to the Institution of Civil Engineers, not merely for allowing us the free use of their rooms in which to hold our Meetings, but for the very courteous manner in which the permission is given. Their Secretary has written to your Secretaries:—"I trust that every attention is shown to your Council, and the Members of the Society, by the servants of the Institution of Civil Engineers; and I hope that at all times you will freely write to me, in case you may wish any particular arrangements for your reception."

Account of the Treasurer of the British Meteorological Society for the year 1862, July to December.

Receipts.

Date	Particulars	£	s.	d.	£	s.	d.	£	s.	d.
1862.										
July 1.	To Balance							48	1	11
Nov. 3–April.	—Dividend on £400 New 3 per cents.				5	15	6			
Nov. —	Do. £450 do.				6	10	0			
					12	5	6			
Dec. 31.	Subscriptions, by Banker ...	1	0	0						
	Do. Treasurer	39	0	0						
	Do. Collector	17	2	0						
					57	2	0			
	Subscriptions (Life Members):—									
Aug. 4.	Rev. J. Slatter	12	0	0						
„ 7.	B. Barrow, Esq.	12	12	0						
Nov. 12.	R. F. Heath, Esq.	12	0	0						
July 23.	E. J. Lowe, Esq.	12	0	0						
„ „	Capt. A. S. H. Lowe ...	10	0	0						
Nov. 29.	H. M. E. Crofton, Esq.	10	0	0						
					68	12	0			
Dec. 31.	Total *Receipts*							137	19	6
								£186	1	5
1863.										
Jan. 1.	To Balance							£47	8	3

Expenditure.

Date	Particulars	£	s.	d.	£	s.	d.	£	s.	d.
1862.										
Aug. 4.	Paid Banker's Commission on Country Cheque ...							0	1	0
Sept. 30.	Paid Assistant Secretary—July, August, September							13	0	0
Dec. 31.	Do. do. October, Nov., Dec.							13	0	0
	Do. Printing Cards of Meetings				1	5	0			
	List of Members				4	0	0			
	Catalogue of Books, &c.				3	11	0			
	Prospectus and Circular				2	0	0			
	Eleventh Report of Council				27	17	6			
	Proceedings, No. 4 ...	£21	9	6	18	6	6			
	Less, for Advertisements	3	3	0						
	Proceedings, No. 5 ...	20	2	6	18	12	0			
	Less, for Advertisements	1	10	6						
	Registrar-General's Reports for Sept. and Dec. Quarters				2	16	0			
	Do. Printing the above							78	8	0
	Do. Binding Books, Pamphlets, &c.							9	12	2
	Do. Postage Stamps				8	0	8	13	13	4
	Do. Stationery				5	12	8			
	Do. Secretary's Postage Stationery (C. V. W.)				1	4	5	2	13	6
	Do. Librarian's do. (H. S. E.)				1	9	1			
	Do. Collector's percentage							0	17	0
	Do. Attendance, Refreshments, &c., for Session ...							7	8	2
	By *Disbursements*							138	13	2
	Balance at Banker's				36	13	3	47	8	3
	Do. Treasurer's				10	15	0			
								£186	1	5

HENRY PERIGAL, Jun., *Treasurer.*

The Council cannot conclude without congratulating the Society on its own steady progress, and of the important meteorological works which have been begun, and some completed, in the past year.

That this Report be adopted and printed, was

Moved by E. W. Brayley, Esq., F.R.S., &c.
Seconded by Sir Charles Bright, F.R.A.S., &c.

and carried unanimously.

AMENDMENTS IN THE INSTITUTES.

The following seven Resolutions were in succession passed, ordering Amendments to be made in the 'Institutes' of the Society:—

No. 1.

Proposed by Charles V. Walker, F.R.S., &c., Secretary,
Seconded by Ed. W. Brayley, F.R.S., &c.

RULE 11.—That the words, "agreeably to Form No. 4, in the Appendix hereto," be added after the word "letter" in Rule 11; and that the following form of letter, which has been provisionally used, and approved by the Council at the Meeting held 1863, January 21, be printed as "Form No. 4" in the Appendix to the 'Institutes.'

Form No. 4.

BRITISH METEOROLOGICAL SOCIETY,
186__, ____________.

SIR,—I have the honour to inform you that you have this day been elected a Member of THE BRITISH METEOROLOGICAL SOCIETY. I forward you herewith a copy of the "Institutes of the Society," and a card announcing the days on which the Ordinary Meetings are held.

The Treasurer will advise me that you have complied with the provisions contained in Rule 12, when I shall have the pleasure of forwarding to you the Publications of the Society for the current year.

I have the honour to be,
Sir,
Your obedient Servant,

Secretary.

To ______________________________.

No. 2.

Proposed by F. Galton, M.A., F.R.S., &c.
Seconded by L. P. Casella, F.R.A.S., &c.

RULE 16.—That the following words be added to Rule 16, at the end:—" unless he be elected after the summer recess."

No. 3.

Proposed by H. S. Eaton, M.A., Librarian,
Seconded by L. P. Casella, F.R.A.S., &c.

RULE 24.—That the words, " No. 5 in the Appendix hereto " be substituted, in Rule 24, for the words " prescribed by the Council;" and that the following Form of Diploma, which was used at the last election of Honorary Members, and approved by the Council at the Meeting held 1862, June 18, be printed as Form No. 5 in the Appendix to the 'Institutes.'

Form No. 5.

BRITISH METEOROLOGICAL SOCIETY,
186__, _______________.

WE have the honour to inform you that at the Ordinary Meeting of the British Meteorological Society held at , on 186 , at P.M., you were elected an Honorary Member of this Society, in recognition of the eminent services you have rendered to Meteorological Science.

Witness our hands, this day of 186 .

____________________, *President.*

____________________ }
____________________ } *Secretaries.*

No. 4.

Proposed by Charles V. Walker, F.R.S., &c., Secretary,
Seconded by G. J. Symons.

RULE 34.—That the following be the wording of Rule 34:— " At least Six Ordinary Meetings of the Society shall be held in each session; the Meetings to be held in the months of January, February, March, April, June, and November; the Meetings to be held on the third Wednesday in each month, or on such other day as shall from time to time be ordered by the Council. And the Council shall have power to call additional Ordinary Meetings at their discretion, or of increasing the number of Ordinary Meetings in the session."

No. 5.

Proposed by J. Park Harrison, M.A.
Seconded by F. Pratt.

RULE 35.—That the following words be added to Rule 35, after the word "precisely:"—"or at such other hour as shall be determined by the Council."

No. 6.

Proposed by Charles V. Walker, F.R.S., &c., Secretary,
Seconded by Rev. J. B. Reade, M.A., F.R.S., &c.

RULE 39.—That the words "on the fourth Tuesday in May, at 4 o'clock in the afternoon," be struck out of Rule 39, and the following words be substituted, "immediately after the Ordinary Meeting of the Society in the month of June, or on such other day and hour in the month of June as shall from time to time be determined by the Council."

No. 7.

Proposed by Jas. Glaisher, F.R.S., &c., Secretary,
Seconded by Ed. W. Brayley, F.R.S., &c.

RULE 41.—That the following be the wording of Rule 41:—"The ballot shall commence after the Annual Report has been read; and shall be kept open during such a time as shall be determined by the Scrutineers."

A ballot was then taken, and the following list of Members, prepared and proposed by the retiring Council, was received and adopted as Officers and Council for the Session 1863-64.

THE OFFICERS AND COUNCIL

OF

THE BRITISH METEOROLOGICAL SOCIETY,

ELECTED 17TH OF JUNE, 1863.

President.

ROBERT DUNDAS THOMSON, ESQ., M.D., F.R.S. L. & E., 41 *York Terrace, Regent's Park,* N.W.

Vice-Presidents.

ANTONIO BRADY, ESQ., M.M.S.
J. LEE, ESQ., LL.D., F.R.S., F.R.A.S., F.G.S., F.L.S., F.S.A.
S. W. SILVER, ESQ., F.R.G.S.
J. W. TRIPE, ESQ., M.D.

Treasurer.

HENRY PERIGAL, ESQ., F.R.A.S., 57 *Warren Street, Fitzroy Square,* W.

Secretaries.

J. GLAISHER, ESQ., F.R.S., F.R.A.S., *Dartmouth Place, Blackheath,* S.E.
C. V. WALKER, ESQ., F.R.S., F.R.A.S., *Fernside, Red Hill, Reigate.*

Foreign Secretary.

F. GALTON, ESQ., M.A., F.R.S., F.G.S., Hon. Sec. R.G.S., 42 *Rutland Gate,* S.W.

Librarian.

H. S. EATON, ESQ., M.A., 30 *Great George Street,* S.W.

Council.

N. BEARDMORE, ESQ., C.E., F.R.A.S., F.R.G.S., F.G.S., &c.
C. BROOKE, ESQ., M.A., M.B., F.R.S.
W. C. BURDER, ESQ., F.R.A.S.
W. P. DYMOND, ESQ.
J. P. HARRISON, ESQ., M.A.
H. JOHNSON, ESQ.
R. W. MYLNE, ESQ., C.E., F.R.S., F.G.S., F.S.A.
D. SLATE, ESQ.
T. SOPWITH, ESQ., M.A., F.R.S., F.G.S.
BALFOUR STEWART, ESQ., M.A., F.R.S.
G. J. SYMONS, ESQ.
S. C. WHITBREAD, ESQ., F.R.S., F.R.A.S.

The following Resolutions were carried unanimously:—

Proposed by Jas. Glaisher, F.R.S., &c., Secretary,
Seconded by Dr. Lee, F.R.S., &c.

That the cordial thanks of the British Meteorological Society be communicated to the Council of the Institution of Civil Engineers for having granted free permission to hold their Meetings in the rooms of the Institution during the Session that has just ended.

Proposed by E. W. Brayley, F.R.S., &c.
Seconded by G. Farren, Esq.

That the thanks of the Society be given to the Officers for their active services during the Session that has now closed.

Proposed by Charles V. Walker, F.R.S., &c., Secretary,
Seconded by Sir Charles Bright, F.R.A.S., &c.

That the Members of this Society desire to express their cordial thanks to N. Beardmore, Esq., for the able manner in which he has filled the Presidential Chair, and for his uniform courtesy and kindness; and to assure him that on his retirement he carries with him the esteem and respect of all who have had the pleasure of meeting him as our President.

On retiring from the Chair, Mr. Beardmore congratulated the Society on the progress made during the two years he had occupied the Chair, and which he attributed as much to the zeal and activity of the Officers as to the increased and increasing interest taken in the Science.

NOTICE.

Session 1863–64.

The Meetings will be held on the Third Wednesdays in the month, at 25 Great George Street, Westminster, S.W., by the kind permission of

The Council of the Institution of Civil Engineers.

Ordinary Meetings at 7 p.m.

1863.	November	18	1864.	March	16
1864.	January	20	„	April	20
„	February	17	„	June	15

The Annual General Meeting will be held after the Ordinary Meeting on June 15.

Council Meetings.

1863.	October	21	1864.	March	16
„	November	18	„	April	20
1864.	January	20	„	June	15
„	February	17			

INDEX OF NAMES OF PERSONS.

*** Names in capitals indicate election into the Society.

INDEX OF SUBJECTS.

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T.

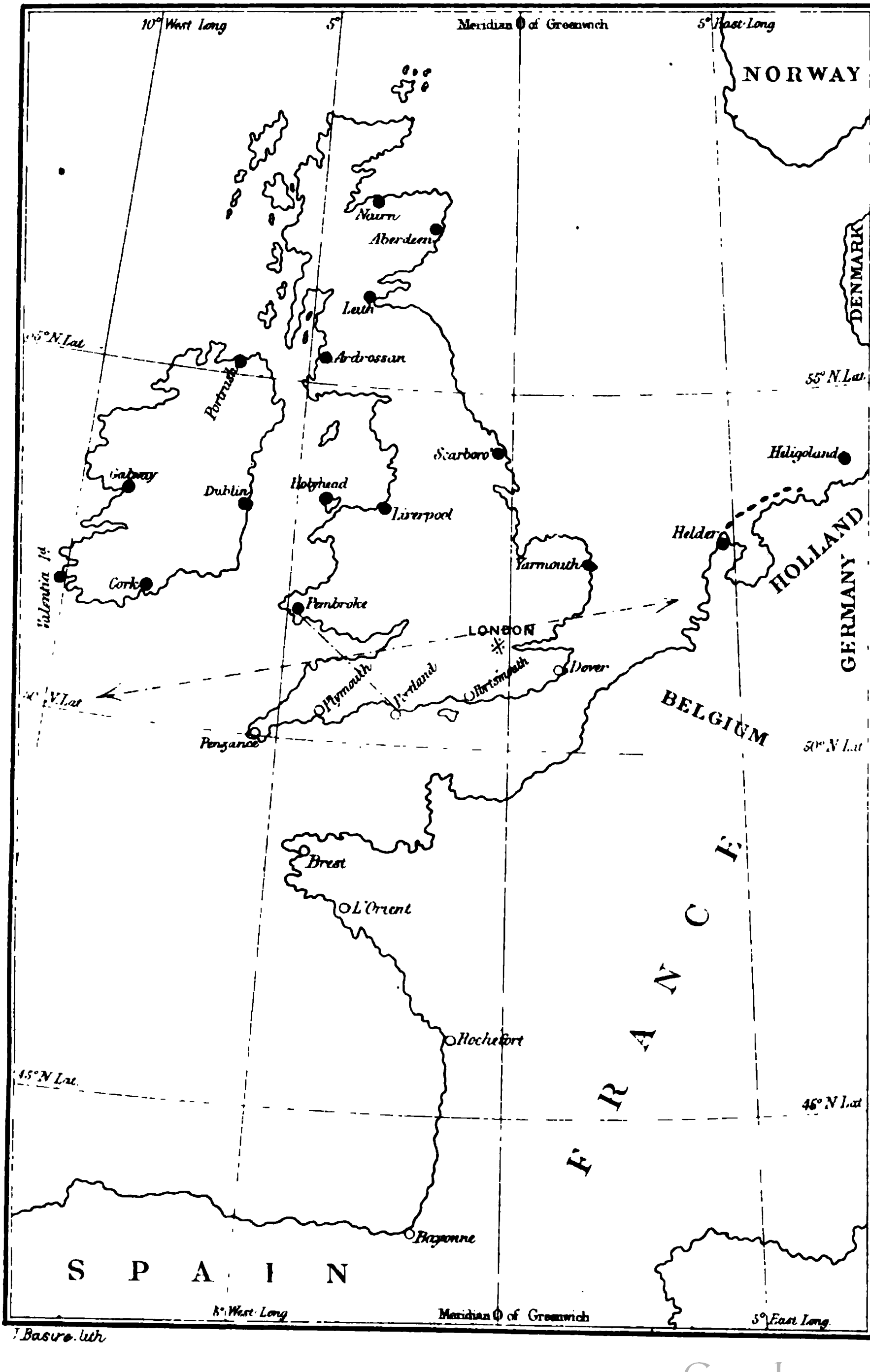
V.

W.

THE END OF VOL. I.

Printed by Taylor and Francis, Red Lion Court, Fleet Street.

Plate XV.



J. Basire. lith

NOTICE TO MEMBERS.

With this Number of the 'Proceedings' Members will receive a Copy of the Revised Amended 'Institutes;' also a copy of the List of Books added to the Library.

Members, whose subscriptions are still outstanding, are requested to forward them to H. PERIGAL, Esq., Treasurer, at No. 57 Warren Street., Fitzroy Square.

The next Ordinary Meeting of the Society is at 7 P.M., November 18, 1863.